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# Hovercraft Skirts: Design Development and Their Drag Characteristics

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Online Presentation via Zoom



**The Hovercraft Society**

## Topics

- 1 Purpose
- 2 Development
- 3 Geometries
- 4 Studies
- 5 Analysis
- 6 Resistance
- 7 Conclusions
- 8 Questions

# 1 Purpose



Figure 8.2: Early Air-Cushion Vehicles in the United States  
(c) Princeton University P-GEM over Water



Figure 8.6: Modified Saunders-Roe Ltd SR.N1 Hovercraft  
(c) Exhibiting Daylight Clearance over Land



Figure 8.6: Modified Saunders-Roe Ltd SR.N1 Hovercraft  
(e) Fitted with 0.31 Meter Skirt



Figure 8.6: Modified Saunders-Roe Ltd SR.N1 Hovercraft  
(f) Fitted with 1.22 Meter Skirt



Figure 4.6: Saunders Roe Ltd  
(o) SR.N5 Hovercraft



## 2 Development



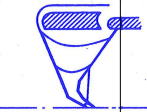

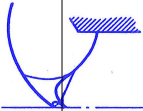
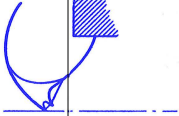
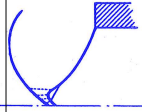
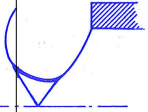
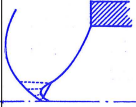
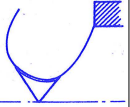
SR.N1						1964	1965
SR.N2							
SR.N3							
SR.N5		Source: Stanton Jones (1968)					
SR.N6	1959	1960	1961	1962	1963		

Figure 9.2: Overall Skirt Development  
(a) Typical Sections through Peripheral Skirts


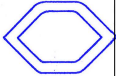

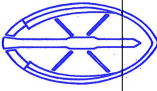


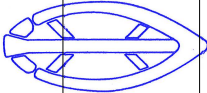
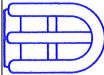
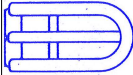
SR.N1						1964	1965
SR.N2						Forward	
SR.N3							
SR.N5	Source: Stanton Jones (1968)						
SR.N6	1959	1960	1961	1962	1963		

Figure 9.2: Overall Skirt Development  
(b) Underside View of Planform Shapes

## 3 Geometries

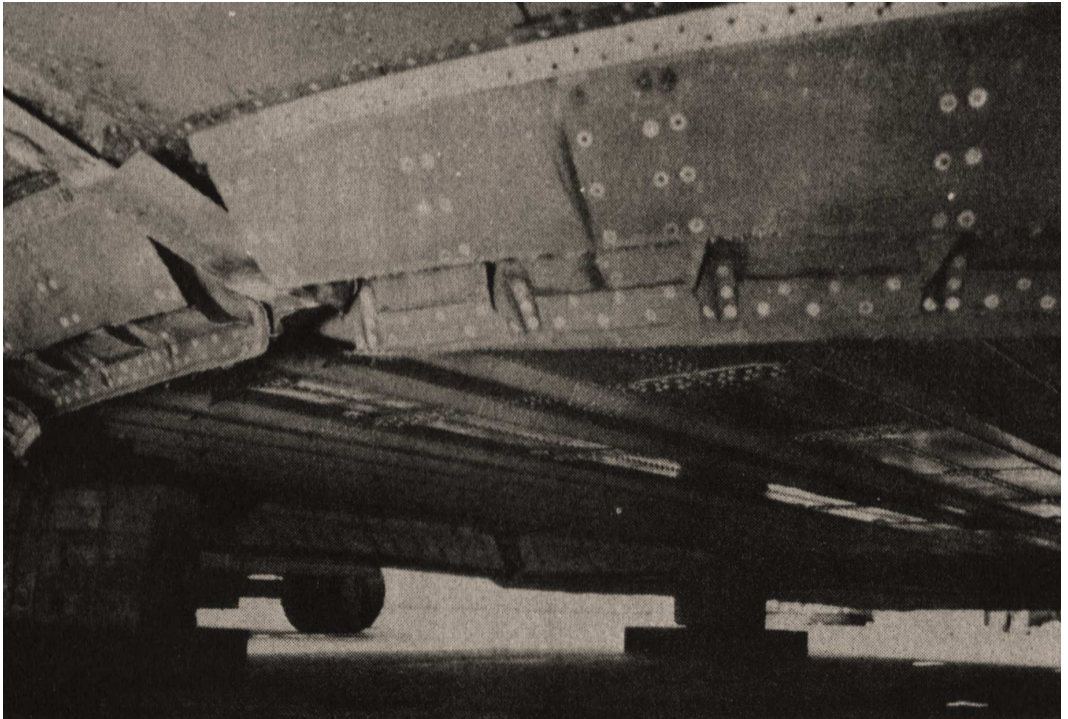


Figure 4.1: Saunders Roe Ltd  
(y) SR.N1 Hovercraft

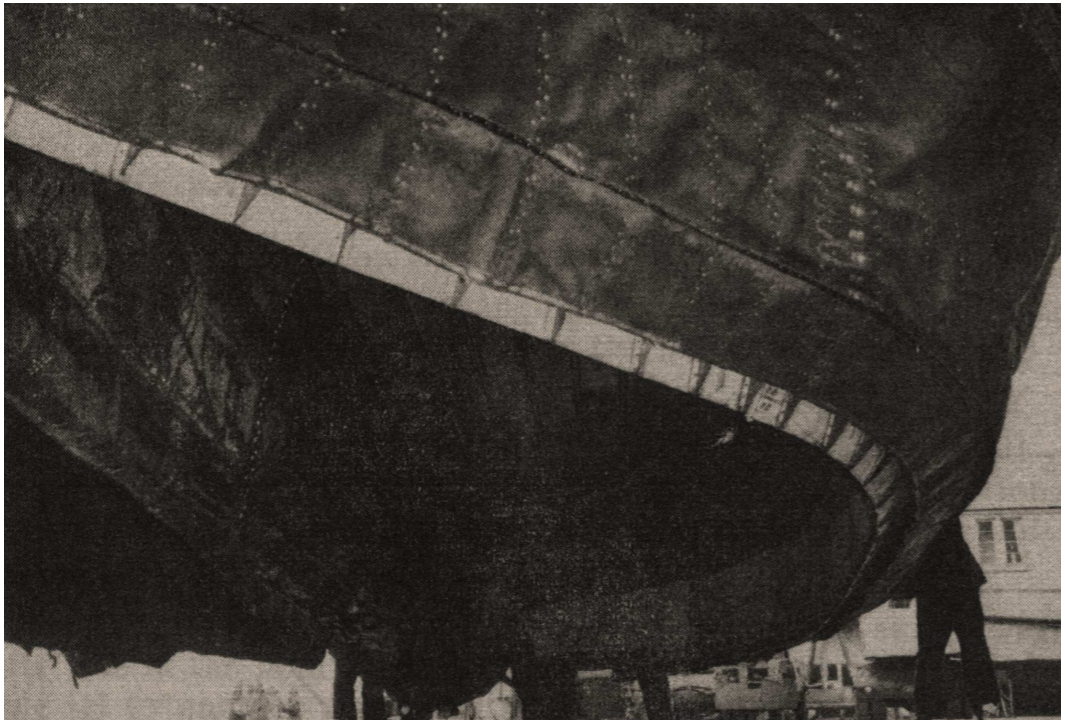


Figure 4.1: Saunders Roe Ltd  
(z) SR.N1 Hovercraft

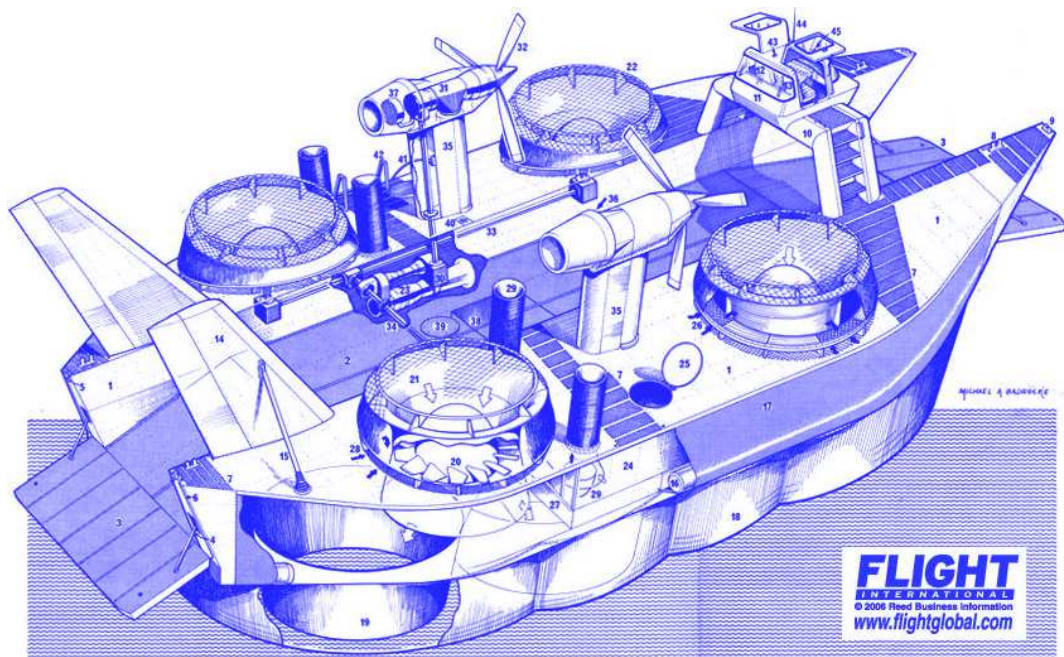


Figure 8.17: SEDAM N.300 and N.500 Naviplanes  
 (a) Cutaway Drawing of N.300

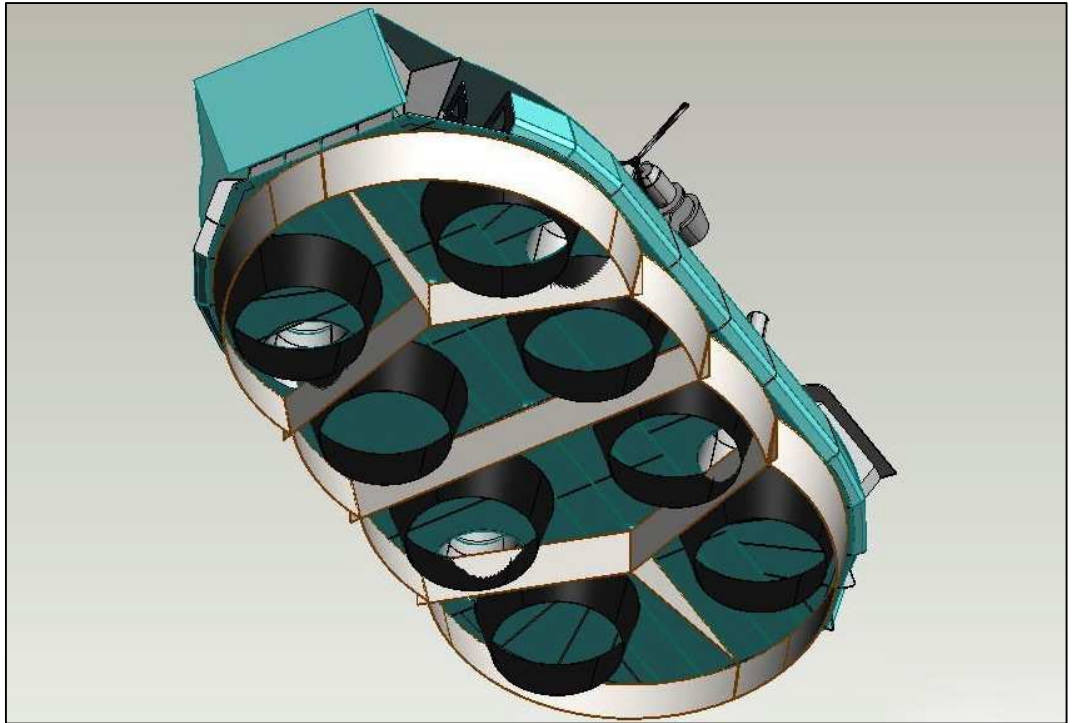


Figure 9.3: Jupes and Pericells  
(a) Arrangement of Jupes of N.320 Naviplane





Figure 8.17: SEDAM N.300 and N.500 Naviplanes  
(d) N.500 with Original Jupes over Land *Ingénieur Jean Bertin*



Figure 8.17: SEDAM N.300 and N.500 Naviplanes  
(e) N.500 with Widened Jupes over Water *Ingénieur Jean Bertin*

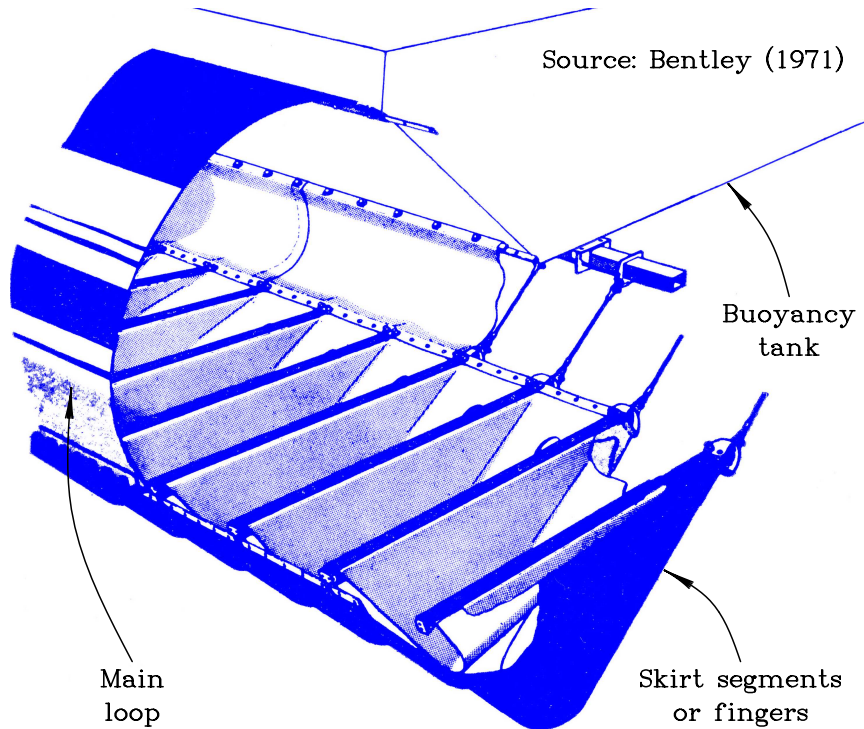


Figure 9.9: Skirt Control on Air-Cushion Vehicles  
(a) Vosper Thornycroft VT1 Open-Loop Skirt

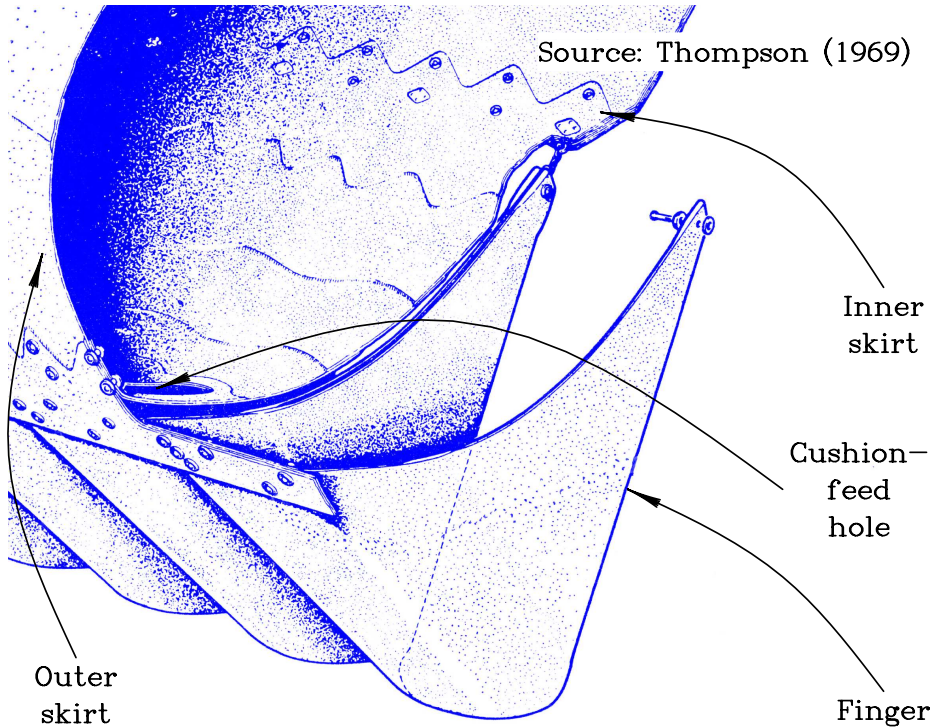


Figure 9.9: Skirt Control on Air-Cushion Vehicles  
(b) Saunders-Roe Ltd SR.N4 Bag and Fingers

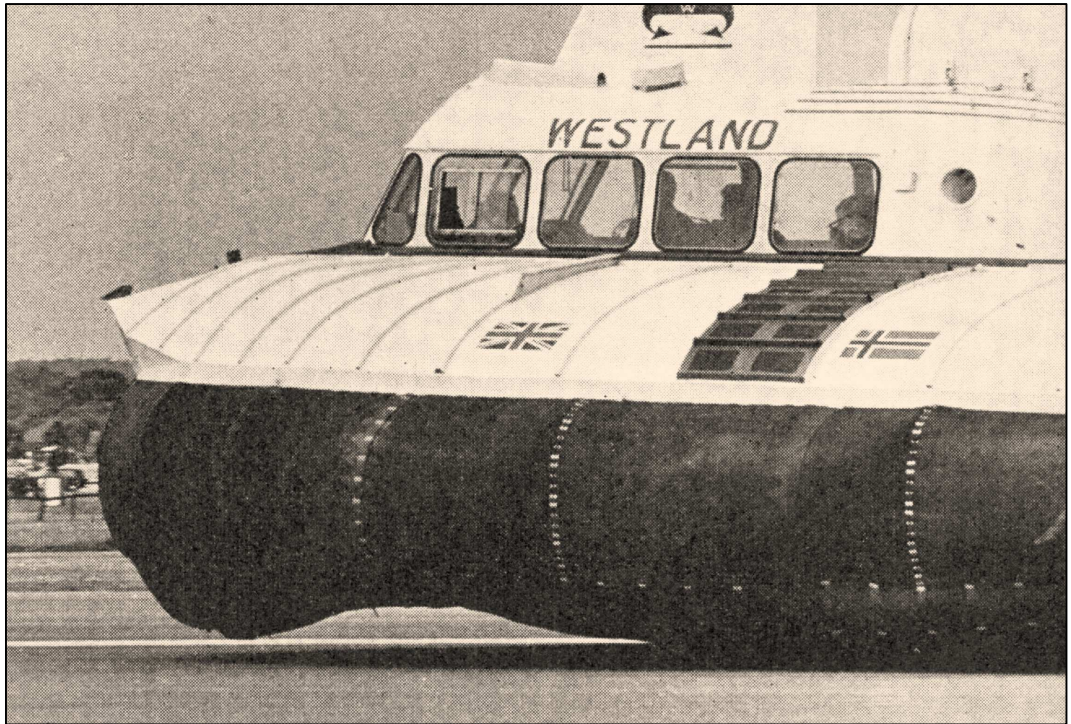


Figure 9.9: Skirt Control on Air-Cushion Vehicles  
(c) Saunders-Roe Ltd SR.N5 Skirt-Lift System

Source: Neal (1969)

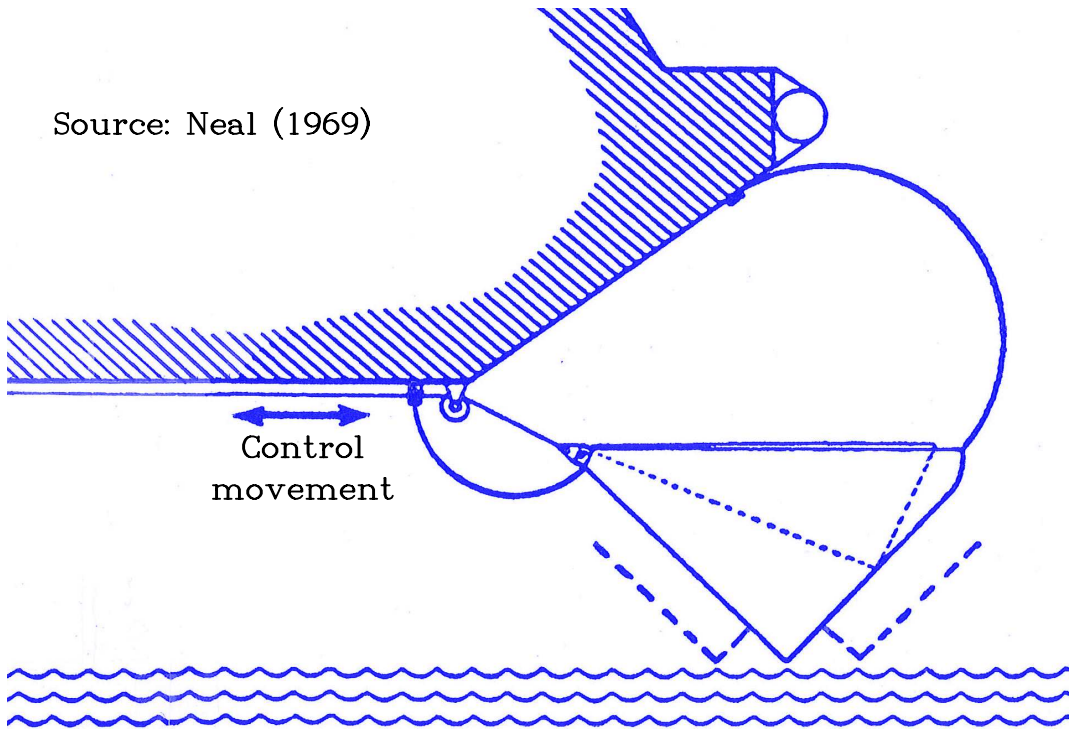


Figure 9.9: Skirt Control on Air-Cushion Vehicles  
(d) Vosper Thornycroft VT1 Skirt-Shift System



Figure 10.17: Umoe Mandel AS Surface-Effect-Ship WaveCraft  
(b) Prototype Craft *Umoe Ventus* at Speed

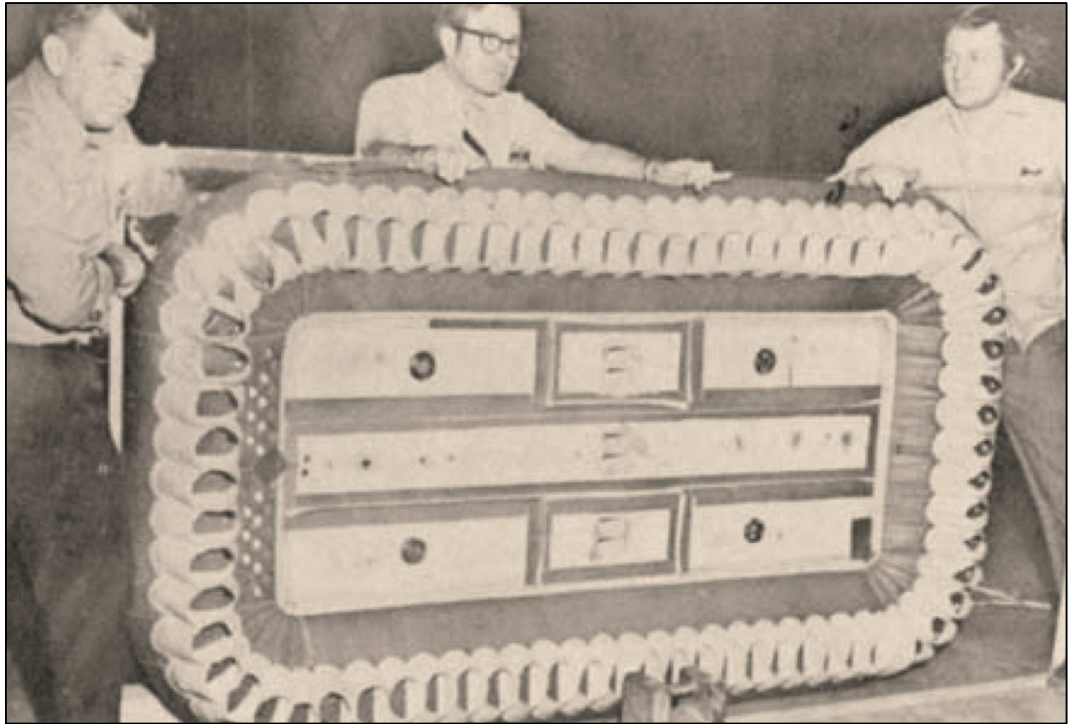


Figure 9.3: Jupes and Pericells

(b) Loop-Pericell Skirt for AALC JEFF (A) 7/100-Scale Model





Figure 8.23: Demonstrators for the AALC Program  
(a) Aerojet-General Corp. JEFF (A)



Figure 8.28: Future Concepts for Large Air-Cushion Vehicles  
(d) Rohr Industries Inc. 3KSES



Figure 9.4: Stern and Rear Corners of Early Skirts  
(a) Saunders-Roe Ltd SR.N2 with 1.22-Meter Skirt



Figure 9.4: Stern and Rear Corners of Early Skirts  
(d) Textron Marine & Land Systems Voyageur Corner View



Figure 9.4: Stern and Rear Corners of Early Skirts  
(e) Saunders-Roe Ltd SR.N5 Hovercraft

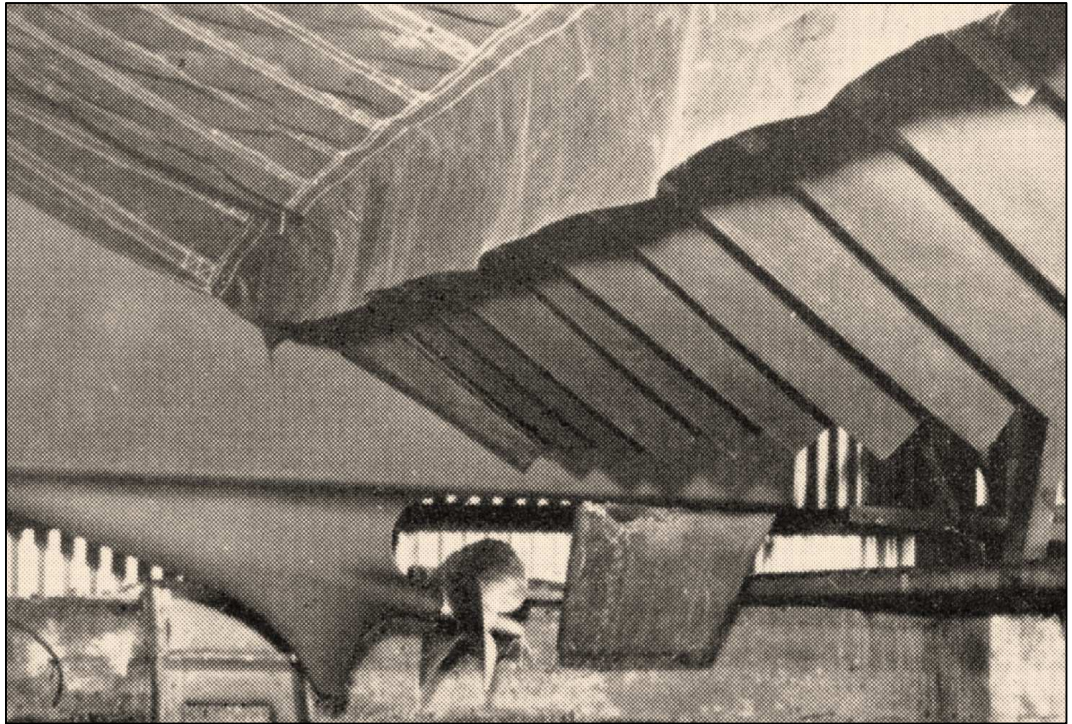


Figure 9.4: Stern and Rear Corners of Early Skirts  
(f) Hovermarine Ltd HM.2 Mark 1



Figure 9.5: Stern and Rear Corners of Modern Skirts  
(c) British Hovercraft Corp. AP.1-88 Hovertravel *Freedom 90*



Figure 9.5: Stern and Rear Corners of Modern Skirts  
(d) Constructions Mecaniques de Normandie AGNES 200



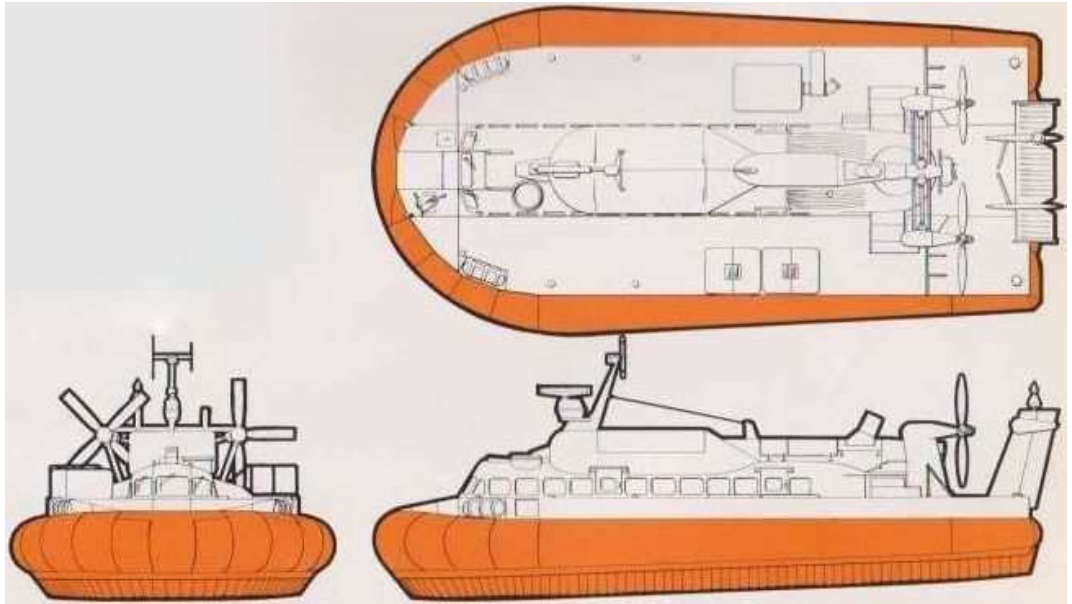


Figure 9.6: Tapered Skirts on Air-Cushion Vehicles  
(a) Saunders-Roe Ltd SR.N6 Mark 6 General Features



Figure 9.6: Tapered Skirts on Air-Cushion Vehicles  
(d) Griffon Hoverwork Ltd 12000TD



Figure 9.10: Plow-In of Jettied-Skirt Hovercraft  
(a) Normal Operation



Figure 9.10: Plow-In of Jetted-Skirt Hovercraft  
(b) Plow-In Phenomenon

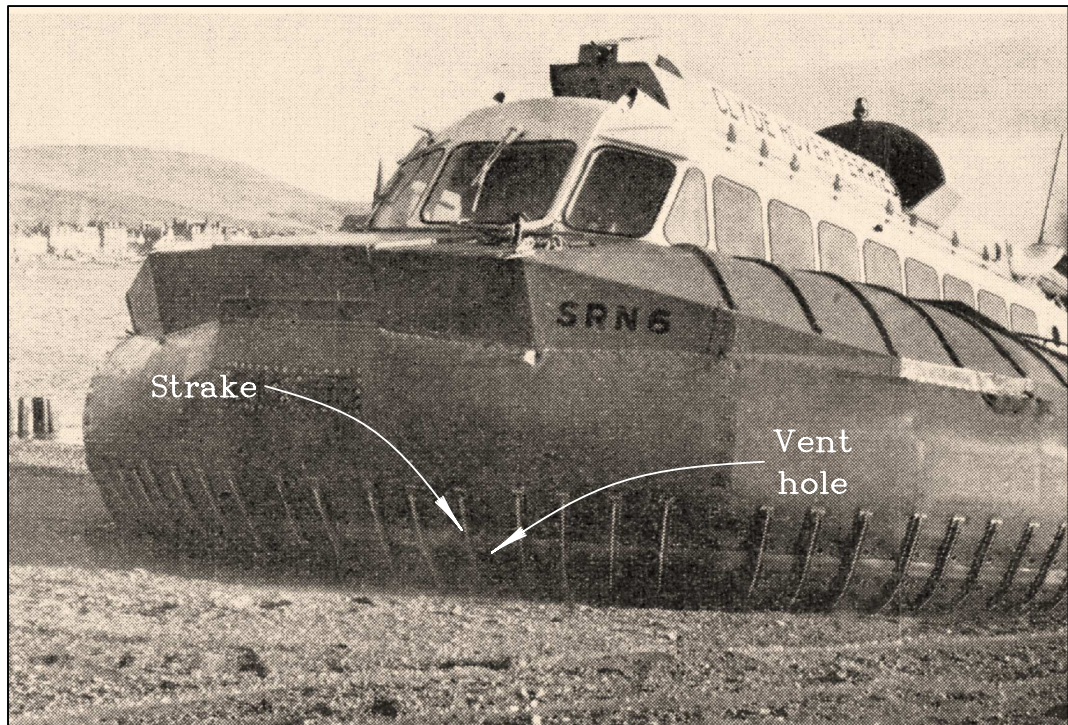


Figure 9.10: Plow-In of Jettied-Skirt Hovercraft  
(e) Strakes and Bleed Holes at Skirt Bow



Figure 9.10: Plow-In of Jettied-Skirt Hovercraft  
(f) Fingers and Studs at Skirt Bow



Figure 9.8: Finnish Navy T-2000-Class *Tuuli*  
(a) Skirt Platform

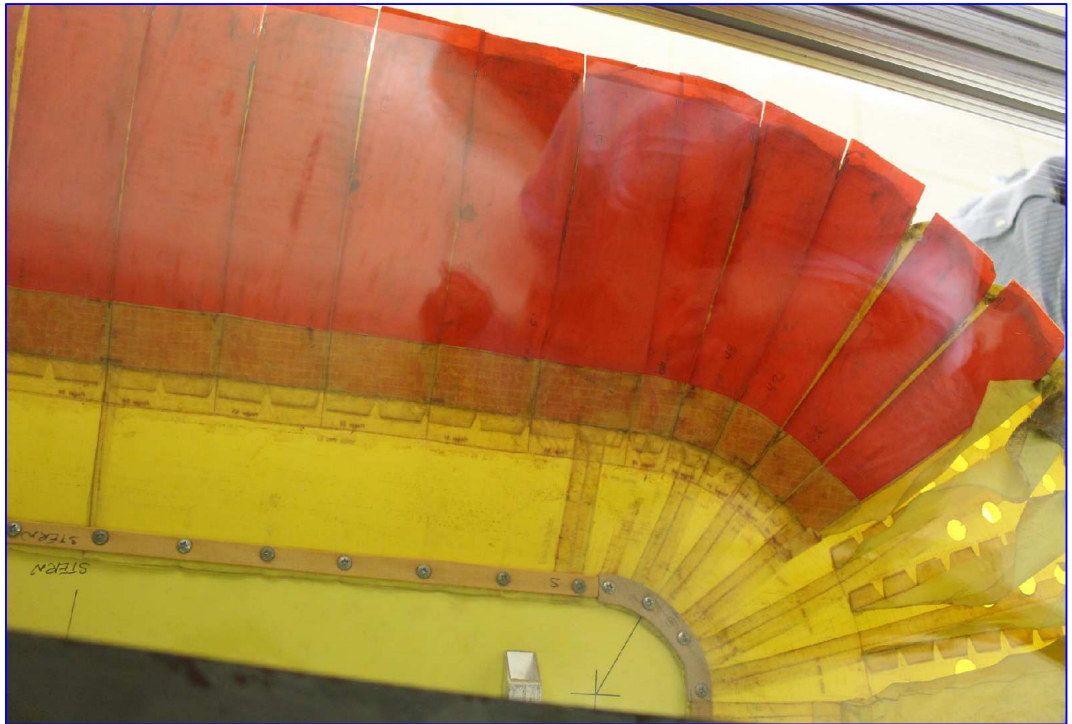


Figure 9.8: Finnish Navy T-2000-Class *Tuuli*  
(e) Starboard Stern Planers





Figure 9.8: Finnish Navy T-2000-Class *Tuuli*  
(f) Prototype Traveling over Water



Figure 8.27: Designs by AKS-Invest Joint Stock Shipbuilding Co.  
(b) MARS-3000

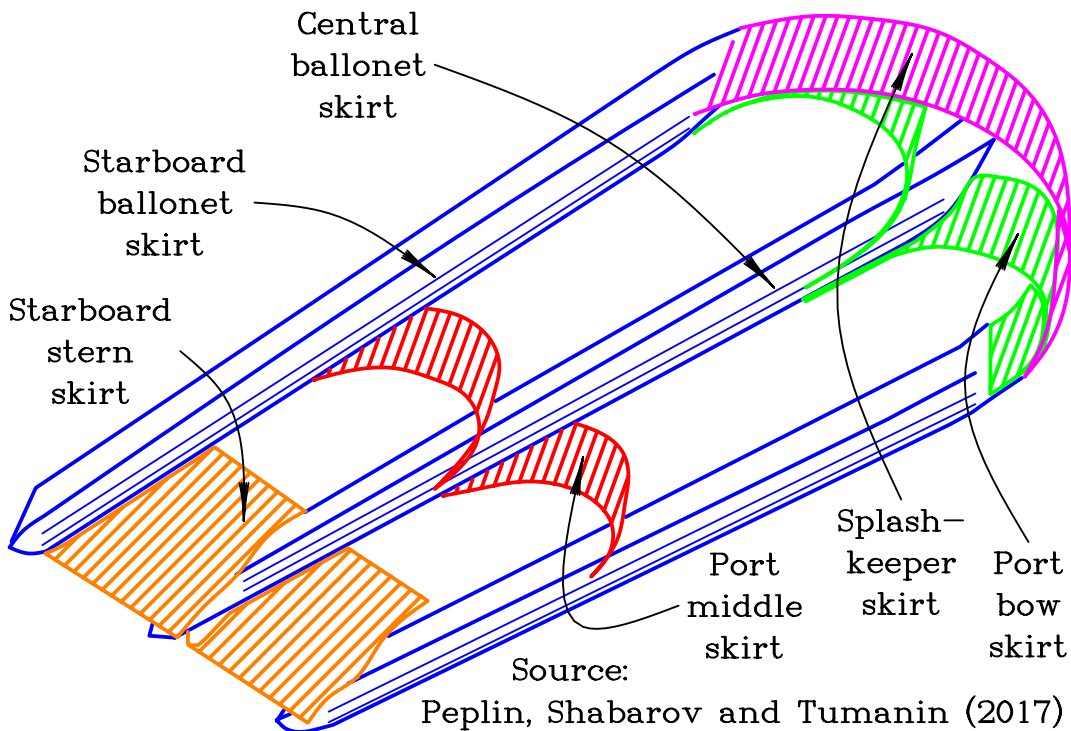


Figure 1001a: 161: Ballonet Skirt



Figure 9.17: Miscellaneous Details of Air-Cushion-Vehicle Skirts  
(a) SR.N4 Finger Attachments



Figure 9.17: Miscellaneous Details of Air-Cushion-Vehicle Skirts  
(b) SR.N4 Worn Fingers



Figure 9.17: Miscellaneous Details of Air-Cushion-Vehicle Skirts  
(d) MV-PP10 Repaired Fingers

## 4 Studies

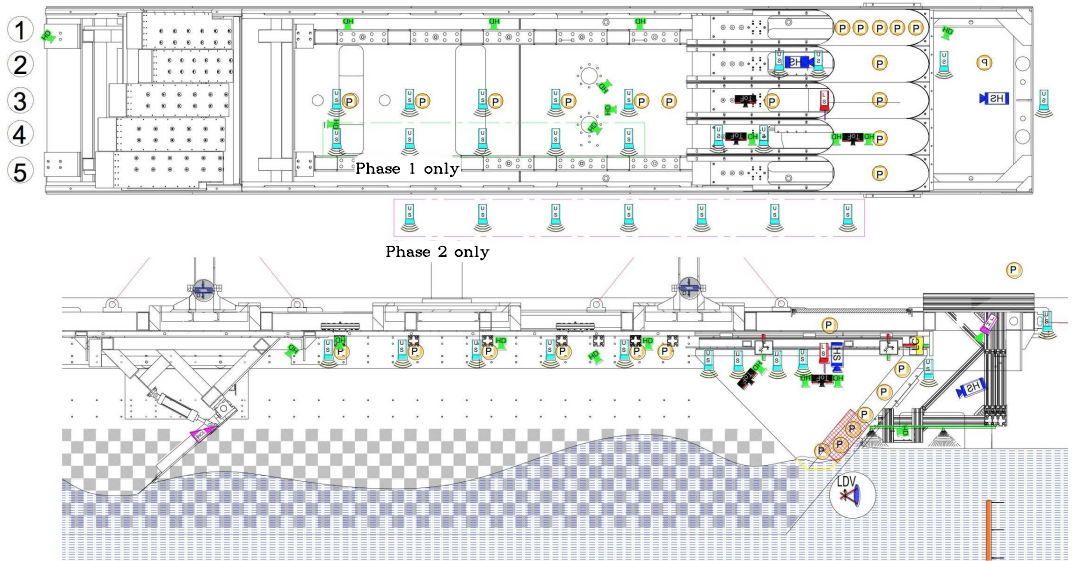


Figure 9.11: Test Apparatus for the Large Cavitation Channel  
(b) Instrumentation



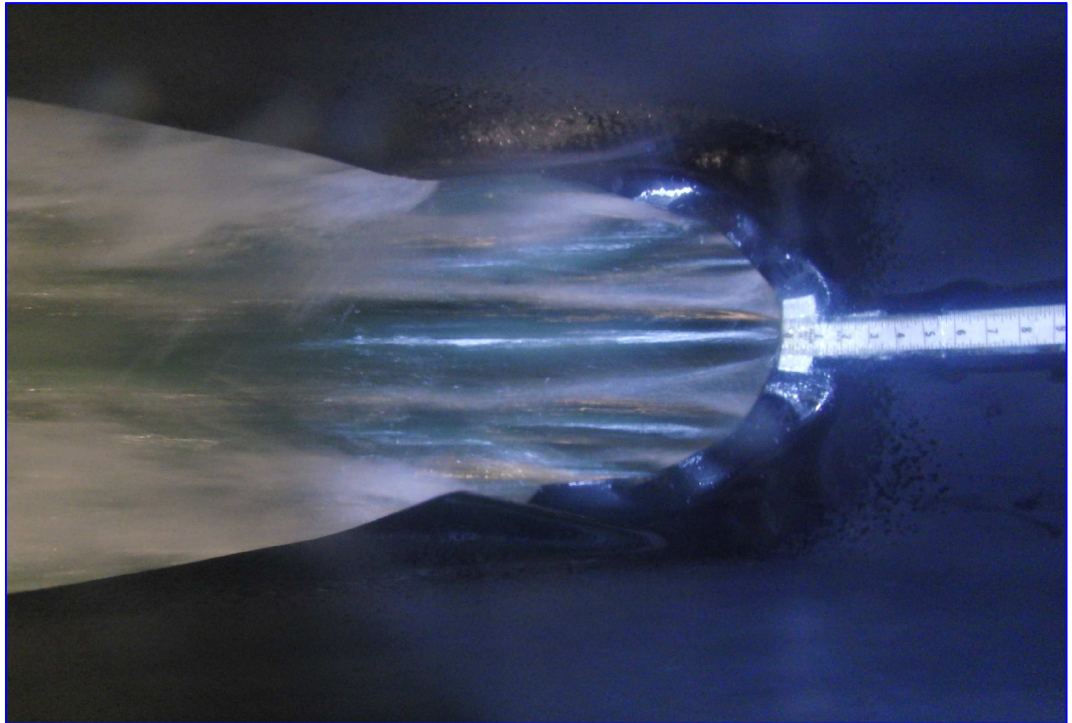


Figure 9.12: Internal Views of Deflected Nitrile Finger  
(a) Deflection 1 and Instant 1

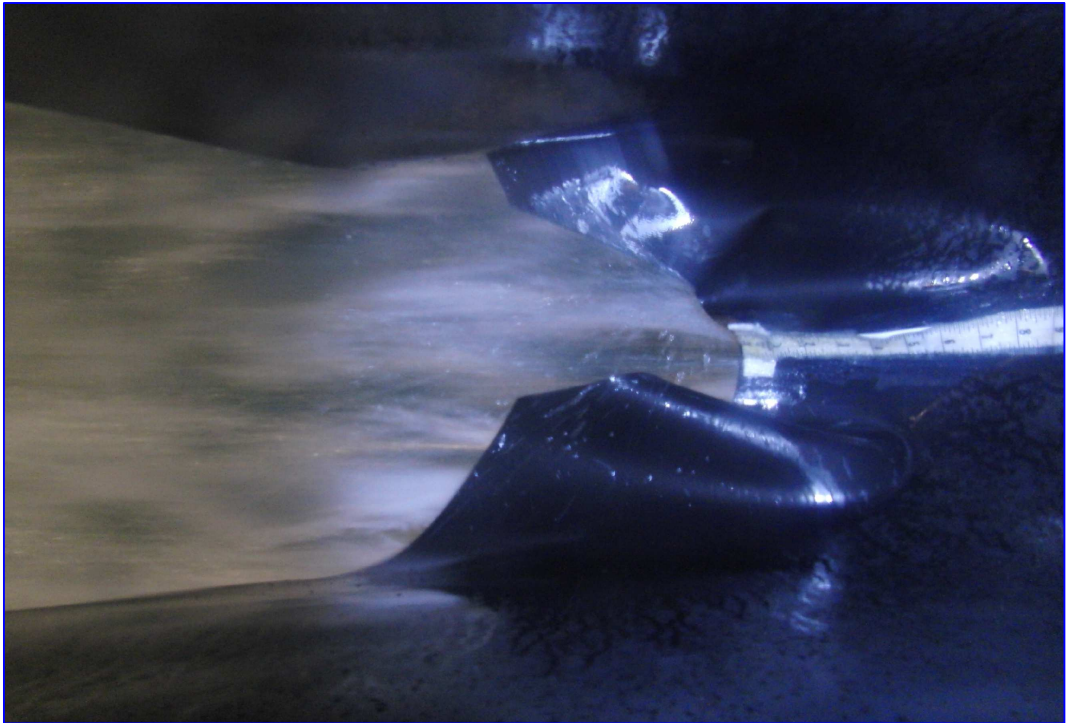


Figure 9.12: Internal Views of Deflected Nitrile Finger  
(f) Deflection 6

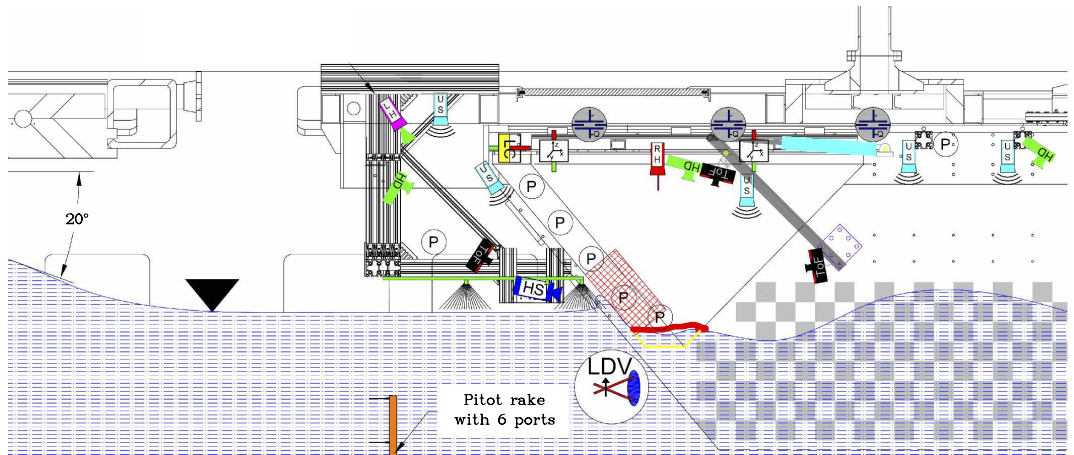


Figure 9.15: Images from Time-of-Flight Cameras  
 (a) Instrumentation of Bow Seal

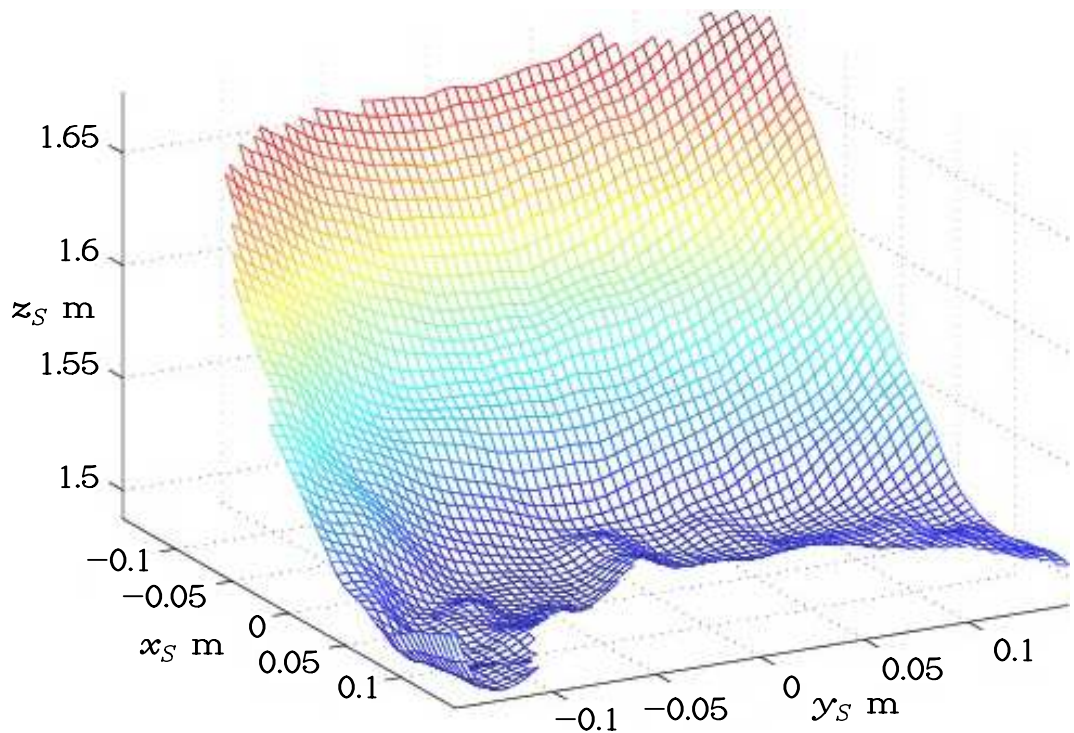


Figure 9.15: Images from Time-of-Flight Cameras  
(b) Hull Mesh Example 1

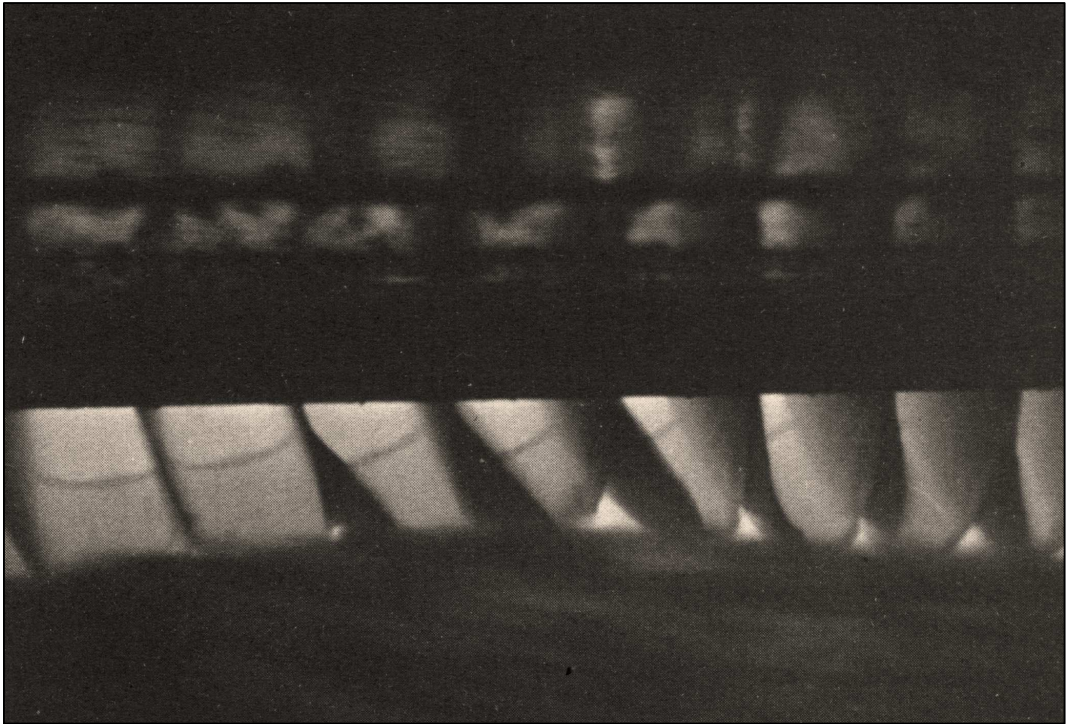


Figure 9.14: Side Skirt of HDL HD.1 Research Craft  
(a) Small Deflection

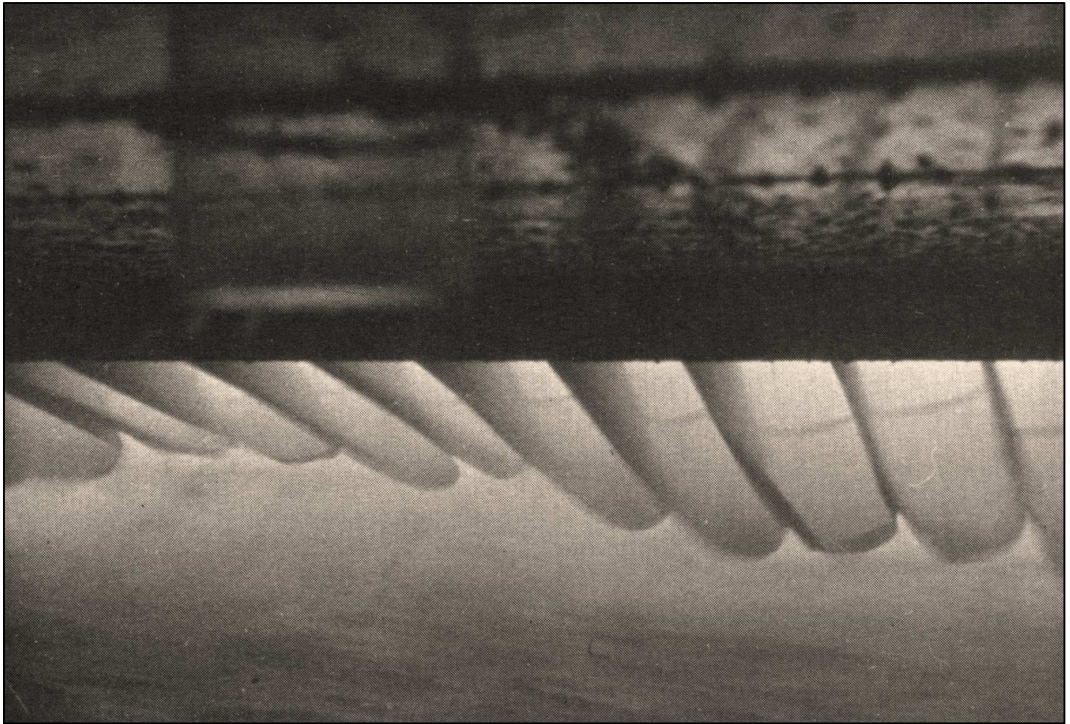


Figure 9.14: Side Skirt of HDL HD.1 Research Craft  
(b) Large Deflection

## 5 Analysis

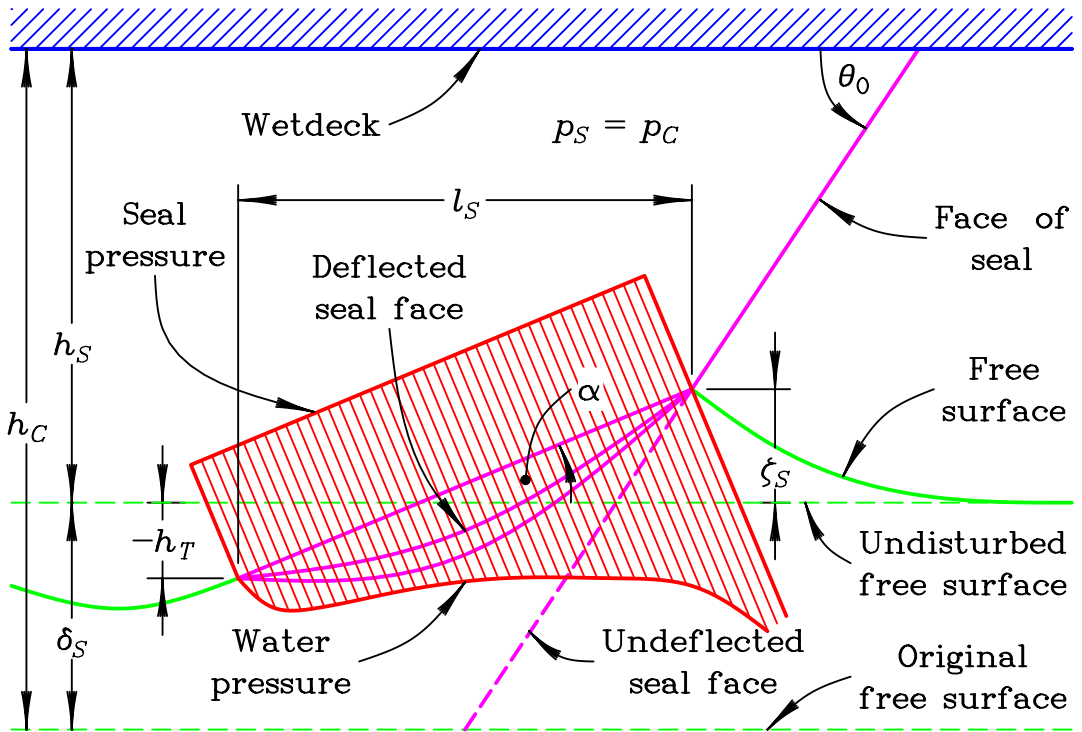


Figure 9.23: Notation for an Idealized Bow Finger Seal



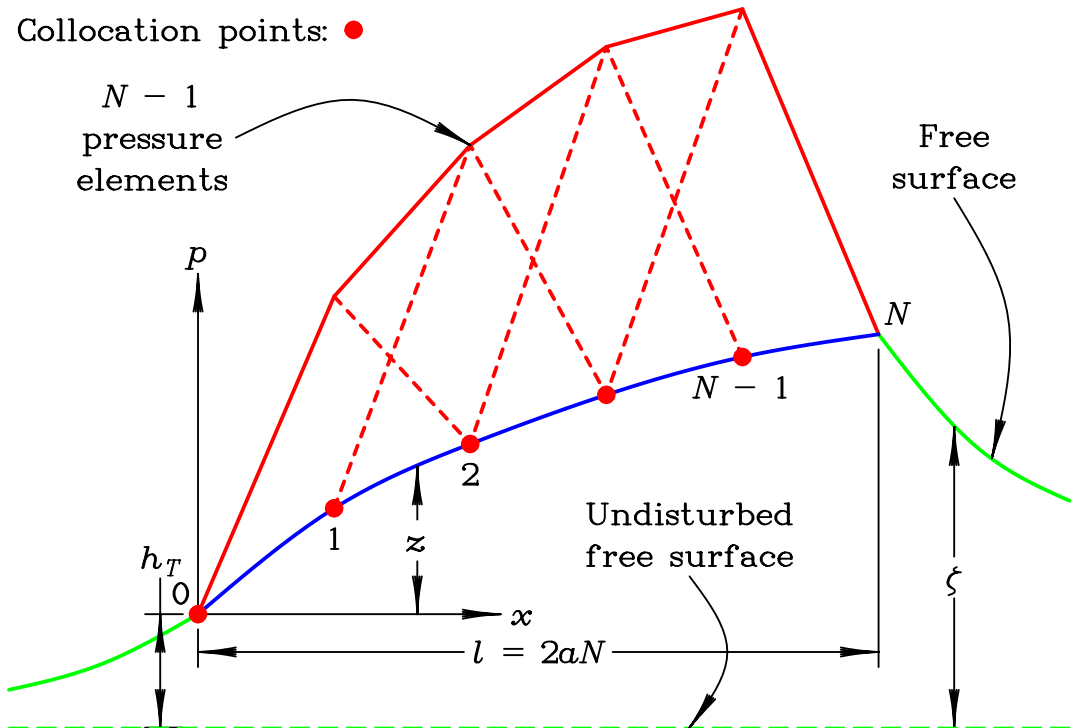


Figure 9.18: Modeling of a Planing Surface Using Pressure Elements  
(a) Notation

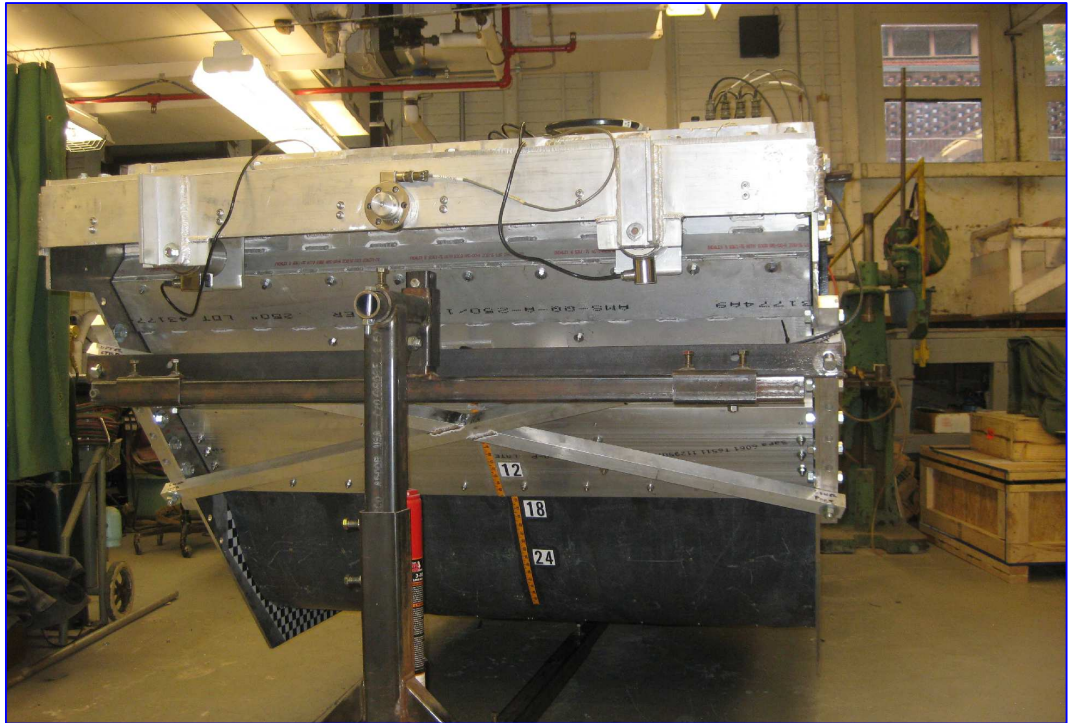


Figure 9.24: Apparatus for Testing a Bow Seal  
(c) Membrane Seal



Figure 9.24: Apparatus for Testing a Bow Seal  
(d) Finger Seal

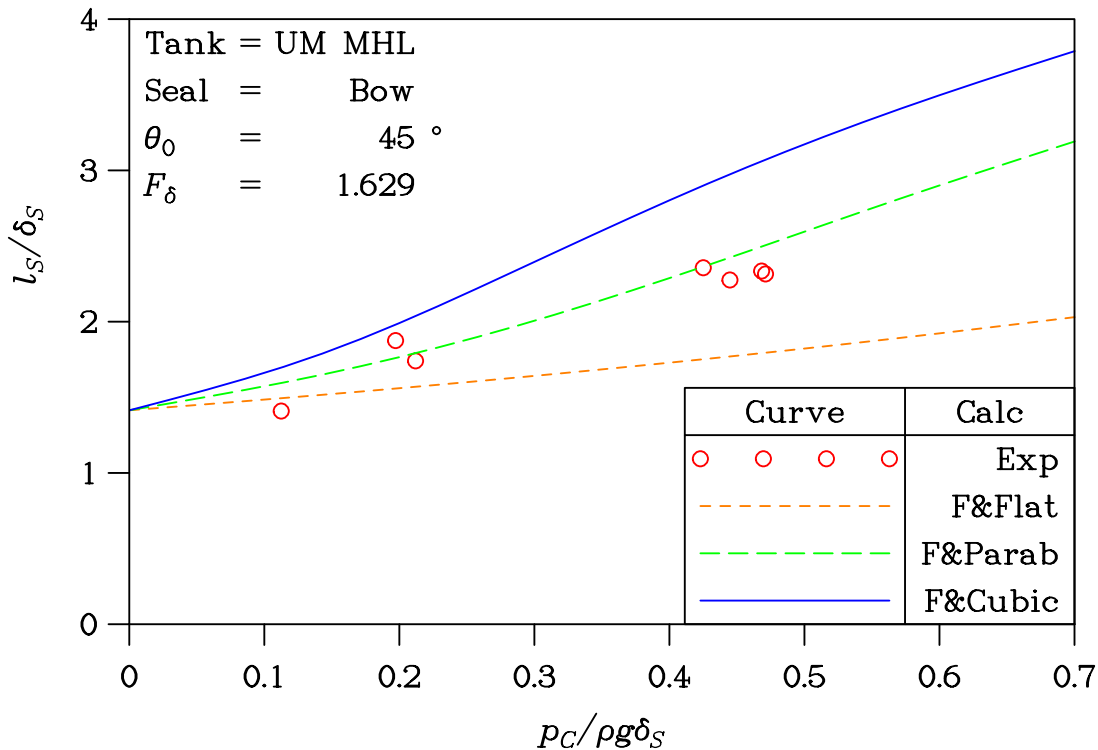


Figure 9.25: Hydrodynamic Behavior of a Bow Seal  
 (d) Wetted Length at  $F_\delta$  of 1.629

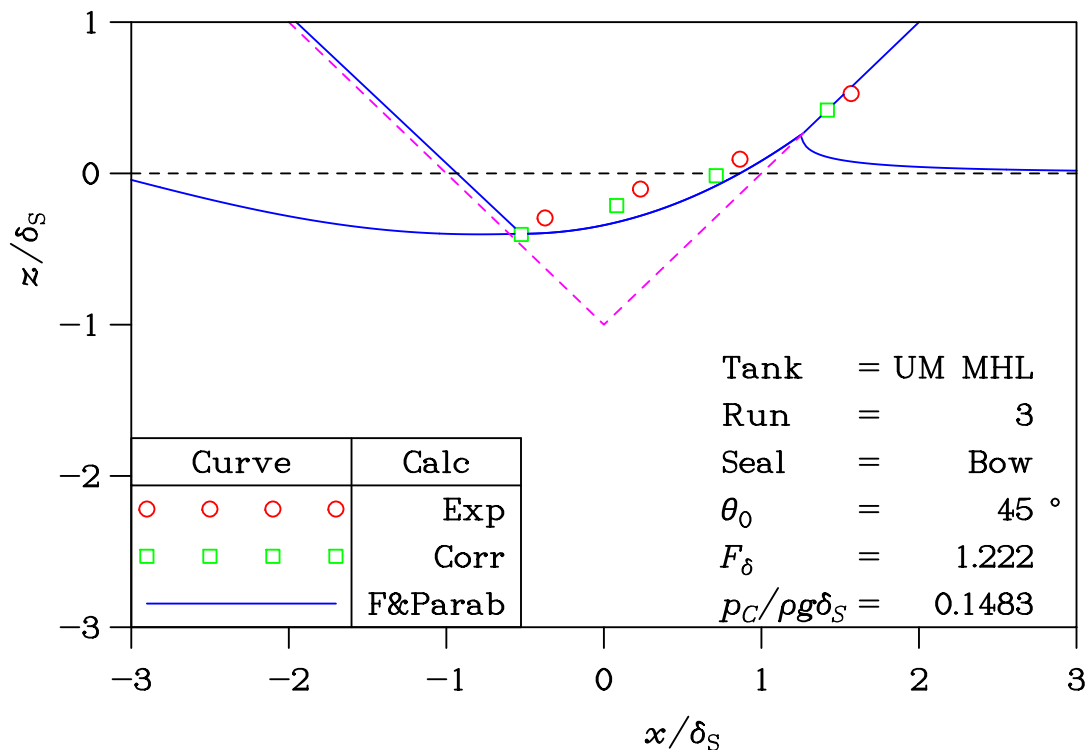


Figure 9.26: Deflected Bow-Seal Shapes  
 (a)  $F_\delta = 1.221$

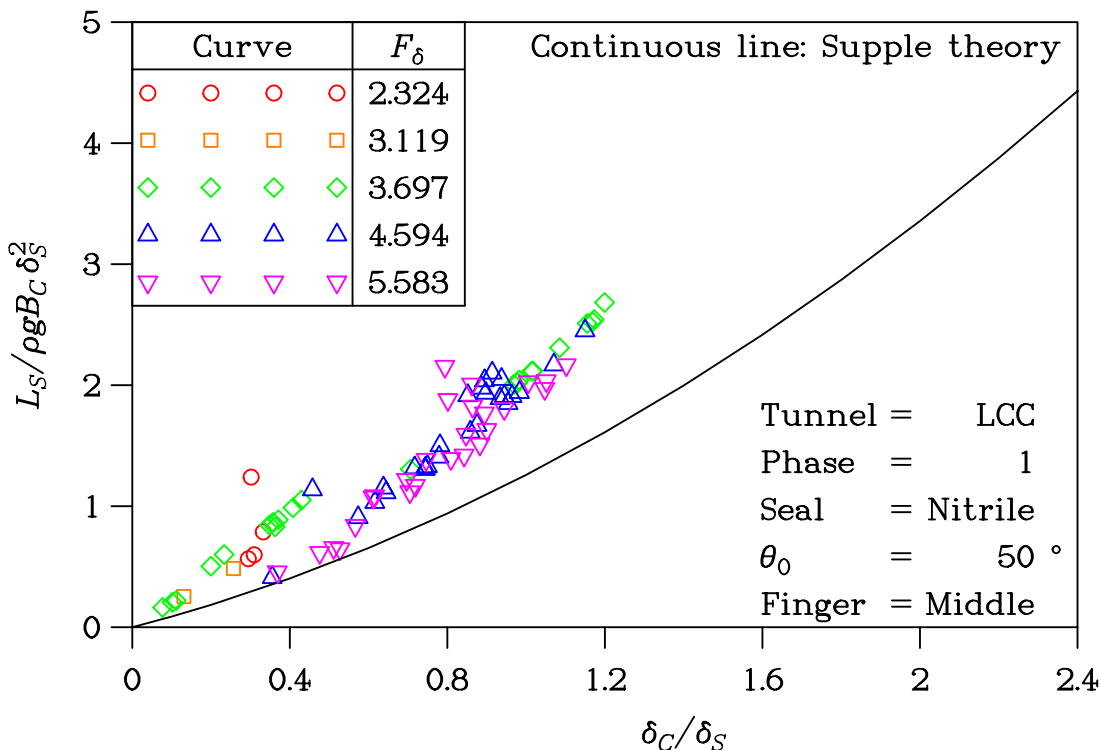


Figure 9.30: Bow-Seal Lift for All Speeds  
 (a) Nitrile Material

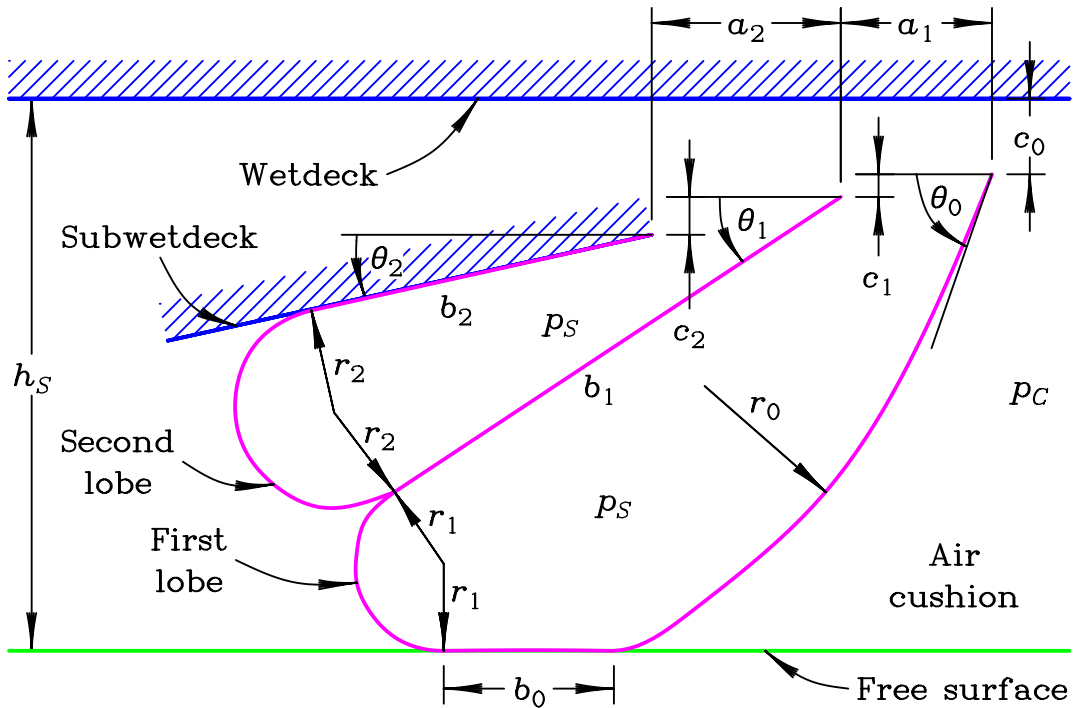


Figure 9.31: Notation for an Idealized Stern Lobe Seal

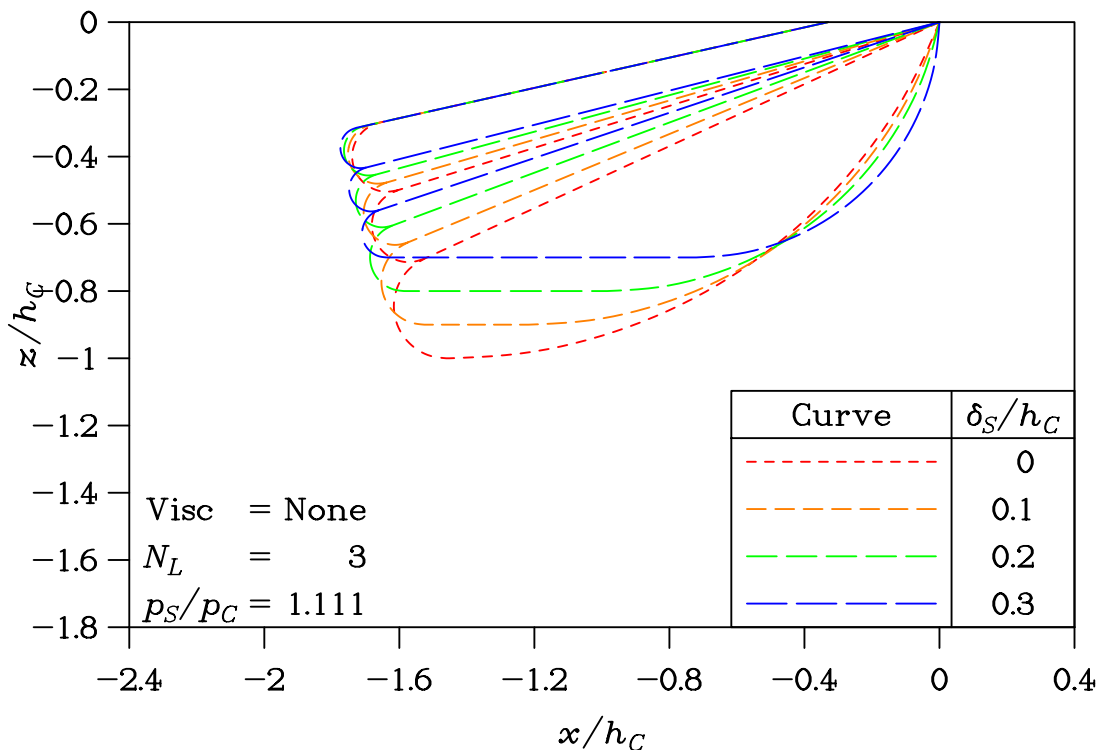


Figure 9.32: Deflection Behavior of a Stern Lobe Seal  
 (c) Three-Lobe Seal and Inviscid



## 6 Resistance



Figure 10.16: T-Craft Models  
(f) Umoe Mandal AS Towing-Tank Model

Table 10.1: Resistance Components of a Surface-Effect Ship

Symbol	Component
$R_W$	Wave
$R_H$	Hydrostatic
$R_V$	Viscous
$R_a$	Aerodynamic
$R_S$	Seal
$R_I$	Intake
$R_J$	Jet
$R_L$	Lift-equivalent

Table 10.2: Grouped Resistance Components  
of a Surface-Effect Ship

Symbol	Definition	Group
$R_T$	$R_W + R_H + R_V + R_a$ $+ R_S + R_I + R_J$	Total
$R_P$	$R_W + R_H$	Pressure
$R_M$	$R_I + R_J$	Momentum
$R_E$	$R_T + R_L$	Effective-total

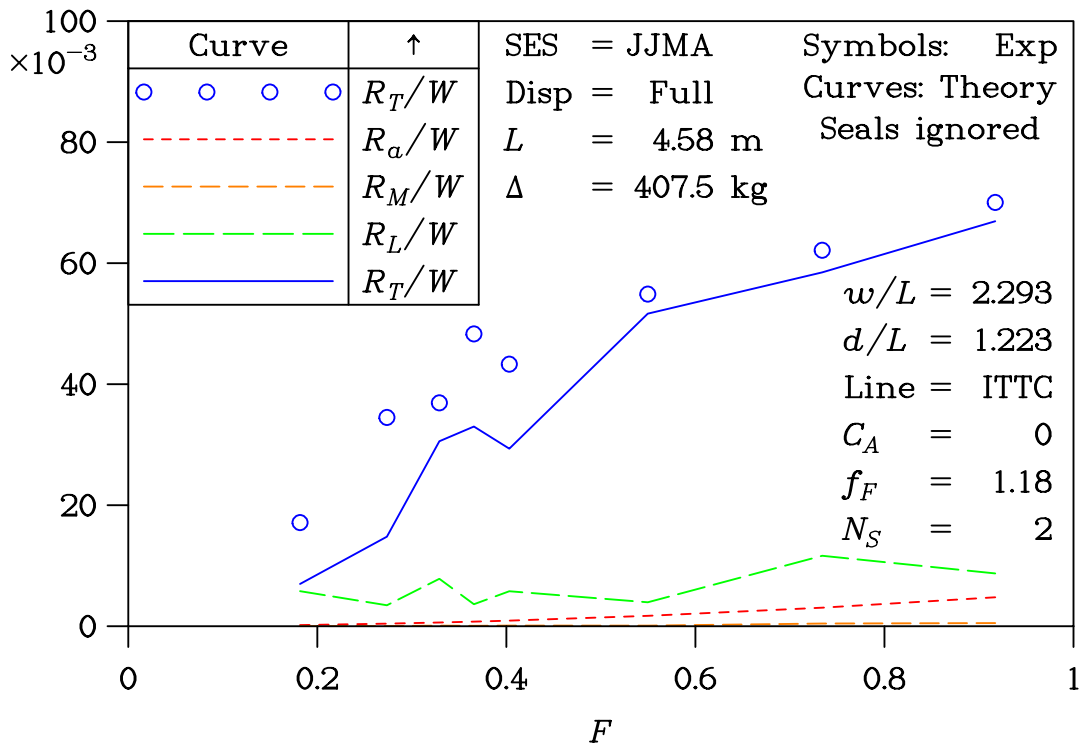


Figure 10.22: Resistance of Littoral-Combat-Ship SES Concept  
 (b) Aerodynamic Components Full Displacement Mass

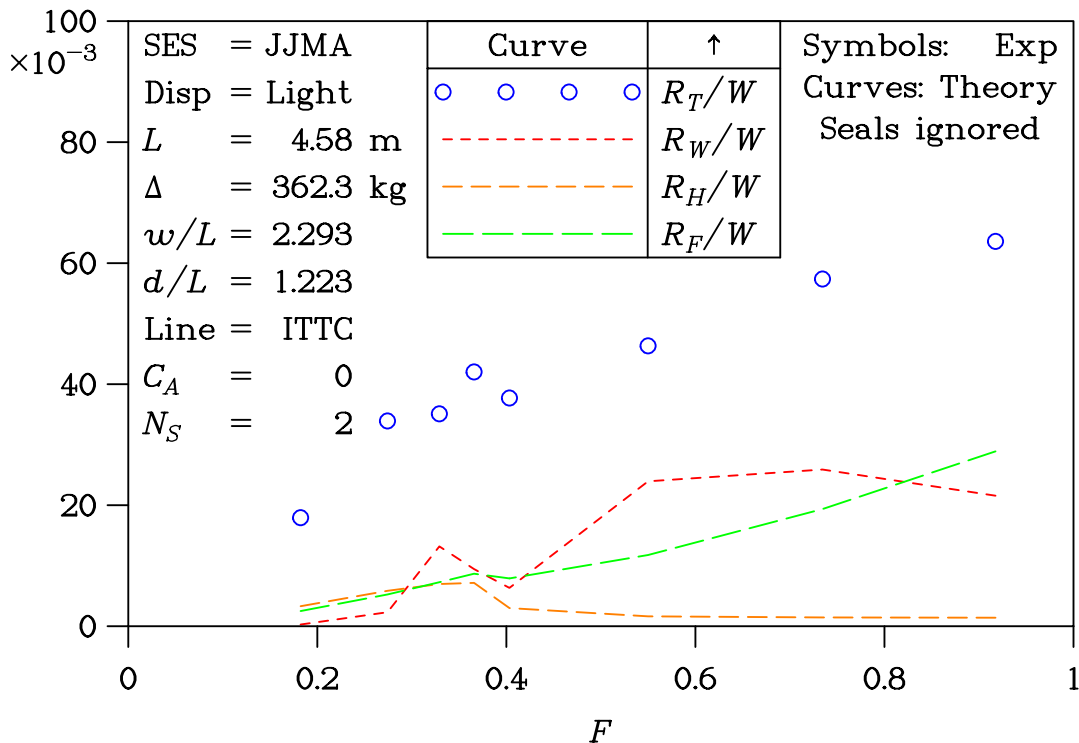


Figure 10.22: Resistance of Littoral-Combat-Ship SES Concept  
 (c) Hydrodynamic Components Light Displacement Mass

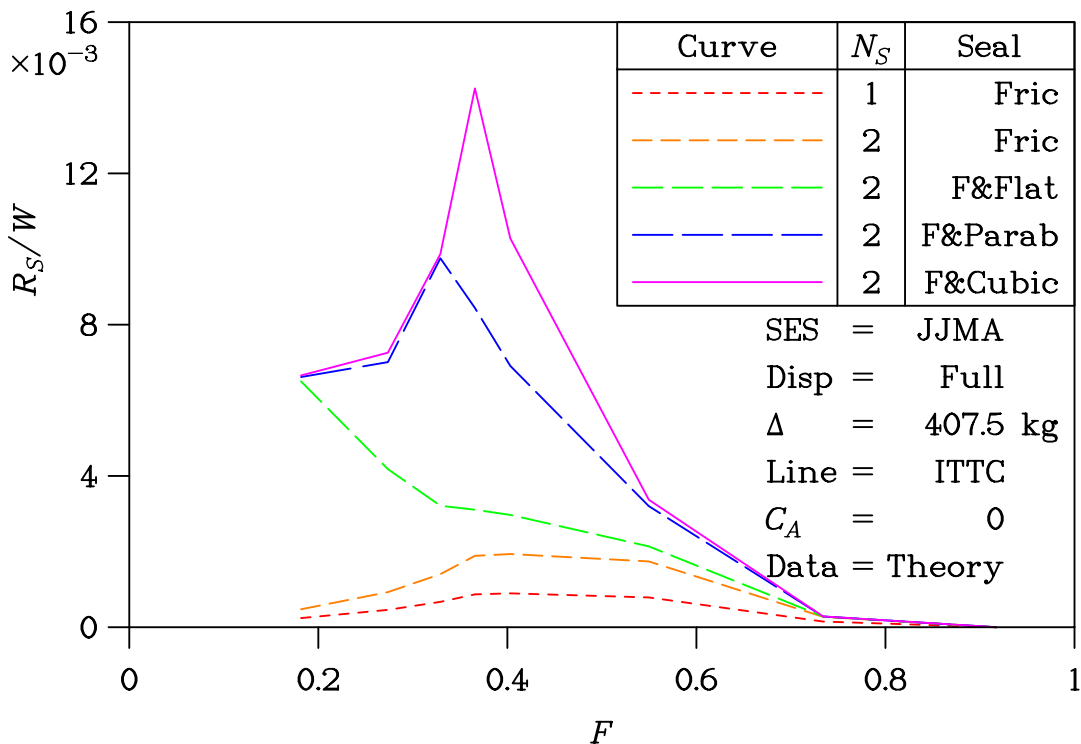


Figure 10.23: Resistance of the Seal System of LCS SES Concept  
 (a) Full Displacement Mass

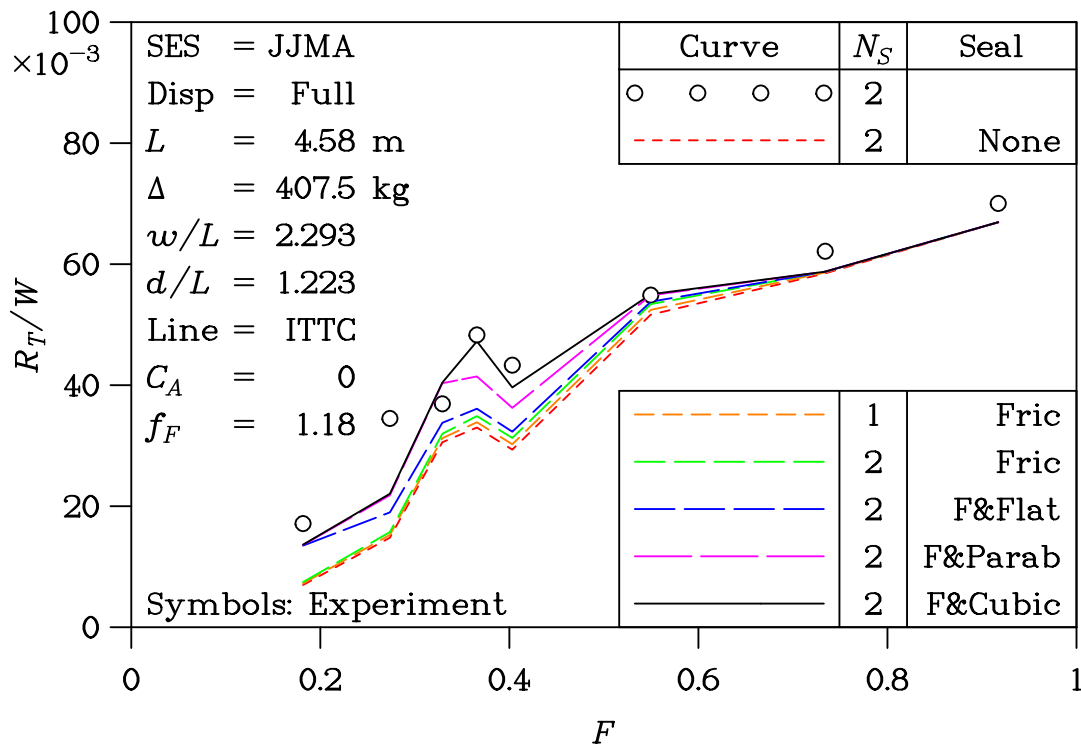


Figure 10.24: Total Resistance of LCS SES Concept  
 (a) Full Displacement Mass



## 7 Conclusions

## 8 Questions