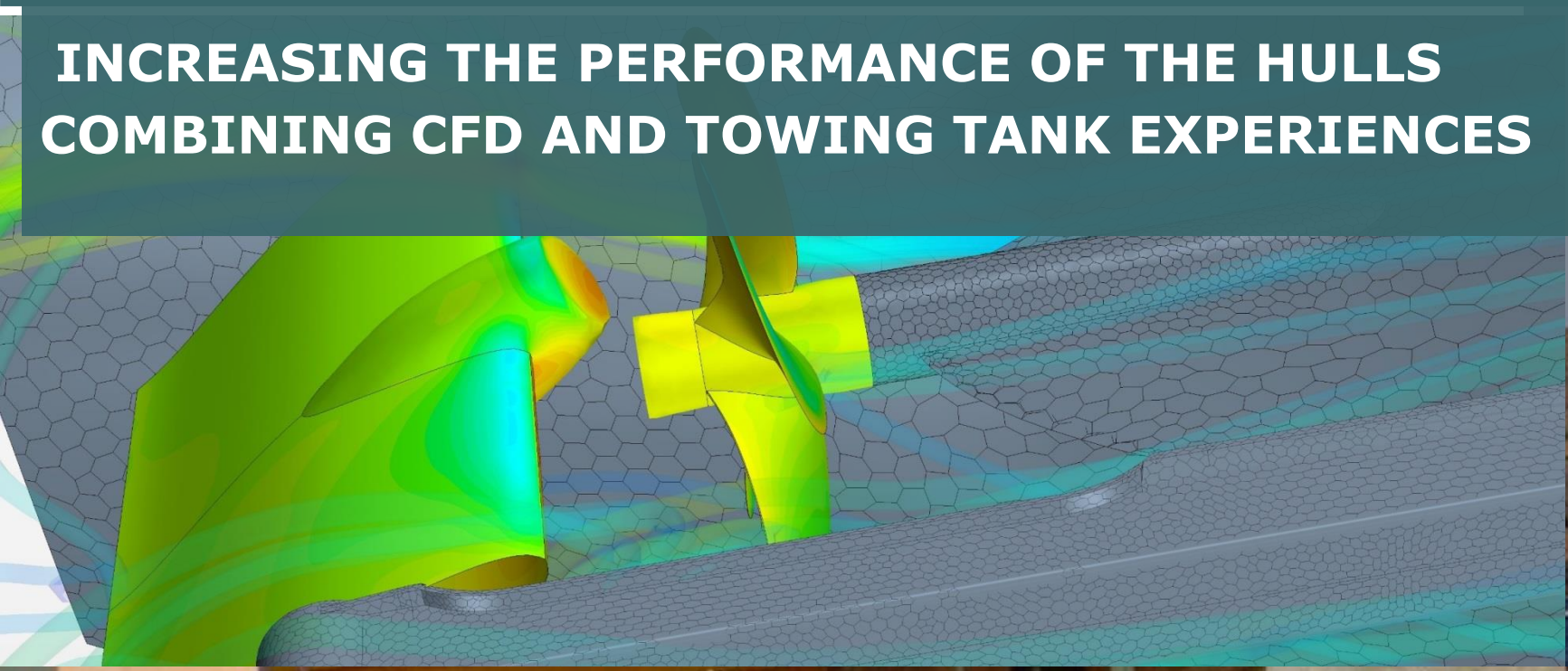
VICUSdt
DESARROLLOS TECNOLÓGICOS

ARMON

INCREASING THE PERFORMANCE OF THE HULLS COMBINING CFD AND TOWING TANK EXPERIENCES

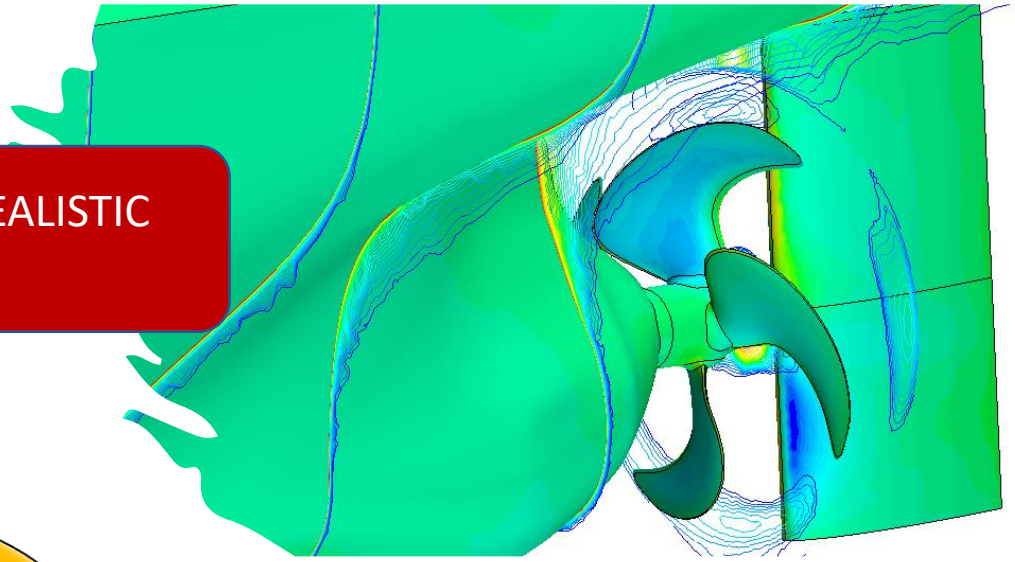


SPANISH IEO RV BOMAG

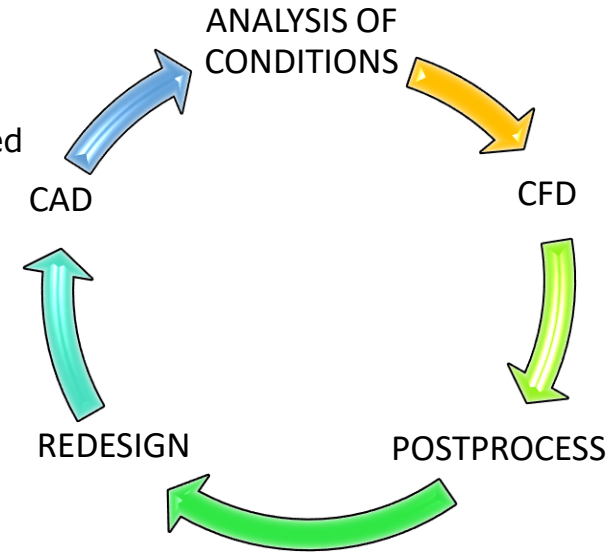
CFD: BASICS

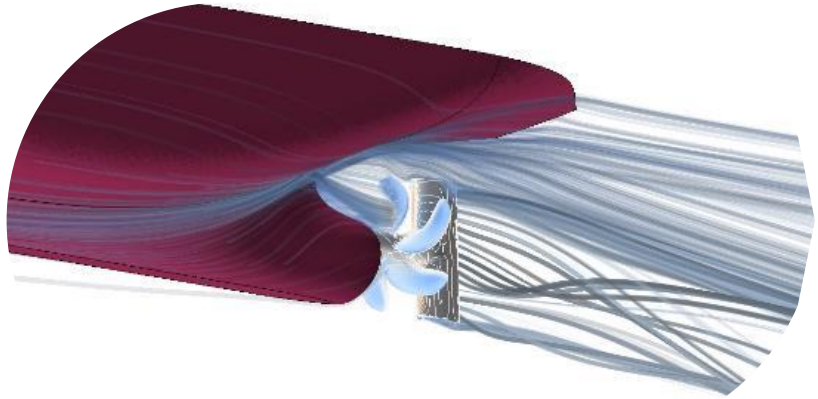
2 - CFD COMPUTATIONAL FLUID DYNAMICS. BASICS

COMPUTER FLUID SIMULATION AT FULL SCALE AND UNDER REALISTIC OPERATIONS



- ✓ CFD= Numerical simulation of the behaviour of any fluid flow
- ✓ CFD and hydrodinamic simulation provides an alternative to towing tank testing.
- ✓ Cheap and more powerful computational power allowed development of numerical simulations





MODEL TANK TESTS USUALLY OCCUR RELATIVELY LATE IN THE DESIGN CYCLE

CFD ALLOW DESIGNERS TO GET QUICK RESULTS IN THE DESIGN PROCESS

CFD OPENS THE WAY TO INNOVATION IN RESEARCH VESSEL DESIGN

1 - OCEANOGRAPHIC RESEARCH VESSELS - HYDRODYNAMIC CHALLENGES

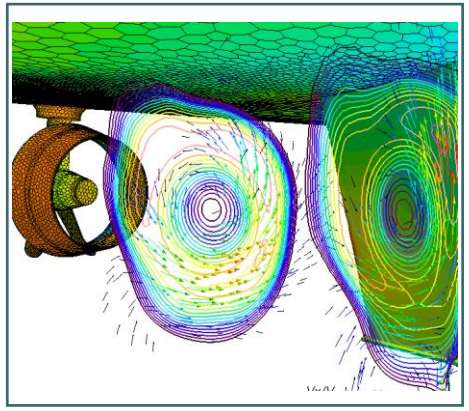
- ✓SUPER SILENT SHIPS
- ✓BUBBLE SWEEP DOWN
- ✓MORE EFFICIENT AND ECONOMIC
- ✓VERSATILE SHIPS

BOMAG: ARMON DESIGN USING CFD TOOLS

ARMON+VICUS THE HISTORY OF CFD ANALYSIS FOR RESEARCH VESSELS

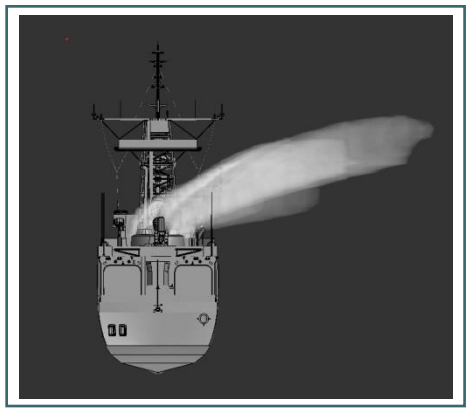
SHIP PROPULSION ENGINEERING. MARINE CFD, ANALYSIS AND DESIGN.

Since **2007**: ***WORKING TOGETHER TO IMPROVE RESEARCH VESSELS PERFORMANCE***



Hydrodynamics (CFD)

- Resistance
- Self-propulsion
- Seakeeping and maneuvering
- Hull optimization
- Bubble sweep down
- Offshore components
- Pressure drop, thermal

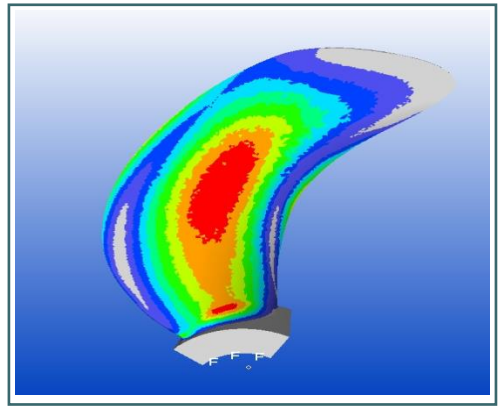


Aerodynamics (CFD)

- Exhaust gas dispersion
- Thermal plume dispersion
- Fire smoke radiation
- Helideck
- HVAC

Ship Propulsion

- Silent Propellers, rudders, nozzles
- Shaft design and analysis (alignment, whirling, torsional)
- Ice Class impact calculations



Structural analysis (FEM)

- Stress
- Fatigue
- CFD coupled analysis
- Shock DDAM with FEMAP NX Nastran

Ship design spiral: NAVAL ARCHITECT NIGHTMARE

MAX 6 MONTHS

OPERATIONAL REQUIREMENTS

- RANGE / TANK CAPACITIES
- DECK OPERATION IN DIFFERENT RESEARCH SCENARIOS
- STABILITY: INTACT AND DAMAGED
- DUAL LNG/DIESEL ELECTRIC PROPULSION
- SAMPLE TO LABORATORY FLOWS

LINES AND BODY PLAN

- LIGHT SHIP / WEIGHT STIMATION
- HULL RESISTANCE / SEAKEEPING
- BUBBLE SWEEPDOWN. GONDOLA ARRANGEMENT
- DROP KEEL ARRANGEMENT
- ACOUSTIC PERFORMANCE OF THE SHIP

ICES REQUIREMENTS

- WAKE FIELD ANALYSIS IN THE PROPELLER DISC AREA
- PROPELLER EFFICIENCY AND PERFORMANCE
- FINITE ELEMENT ANALYSIS OF THE HULL STRUCTURE

TOWING TANK TESTING → START- CUTTING

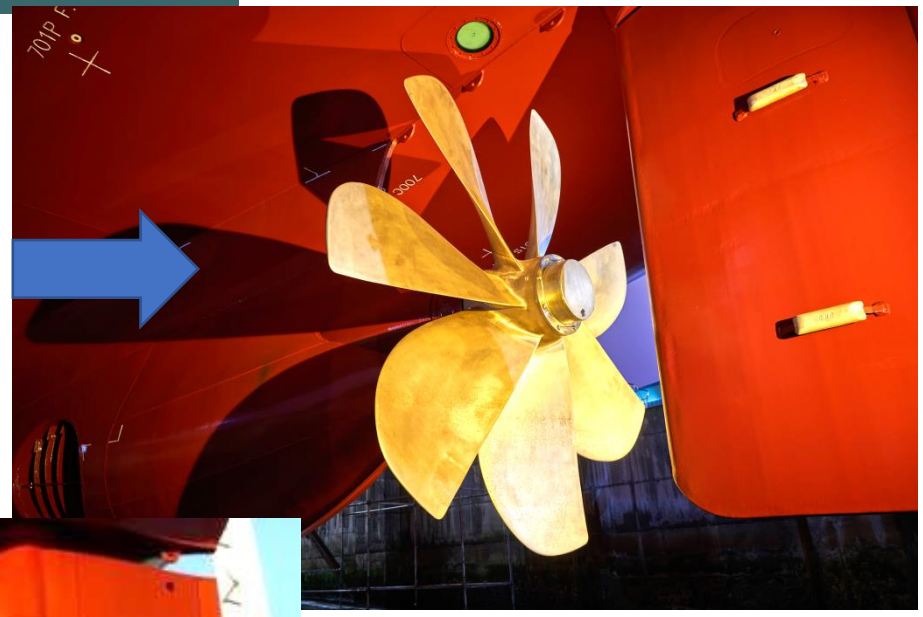
NO FAILURE SHALL BE ALLOWED

CFD: THE ESSENTIAL TOOL IN THE CONCEPT DESIGN PROCESS

3 - CFD ADVANTAGES

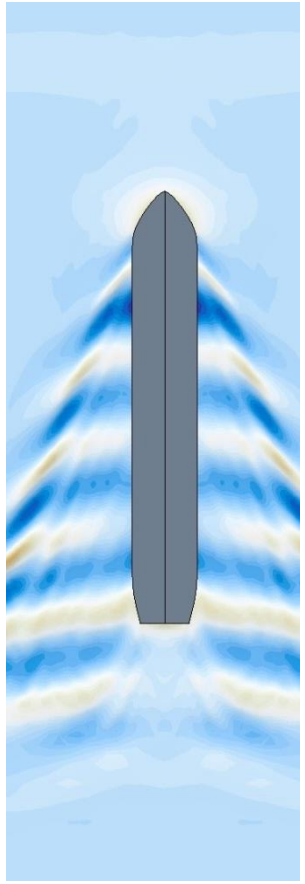
- ✓ Very fast results on dozens or hundreds of alternative designs
- ✓ Allows you to visualize the flow and analyze changes and improvements with detail and accuracy
- ✓ The forces, moments and pressures can be isolated and analyzed for each component of the ship
- ✓ Can be coupled to CAD and algorithms for parametric optimization
- ✓ Process can be automated for faster turn around time.
- ✓ Coupling to FEM for solving complex structural problems
- ✓ Accurate analysis of cavitation
- ✓ Ability to solve complex interactions like turning propeller, rudder and tactical diameter simulation
- ✓ Not only propulsion but also aerodynamics, sloshing, seakeeping, …

CASE STUDY: TOM CREAN PROPELLER REDESIGN



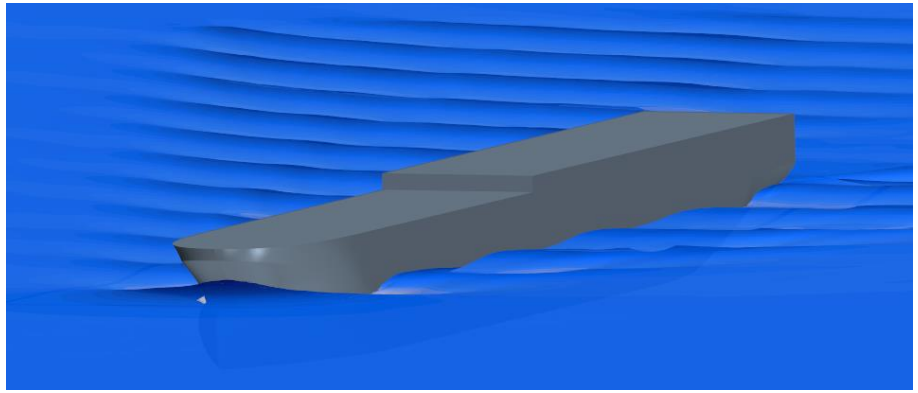
HYDRODYNAMICS

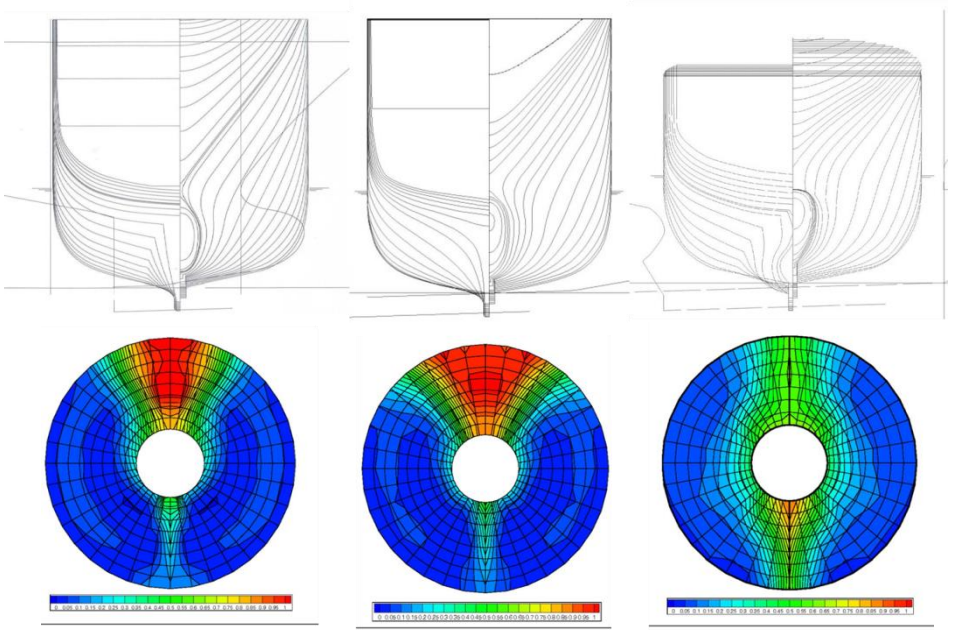
HULL RESISTANCE & OPTIMIZATION

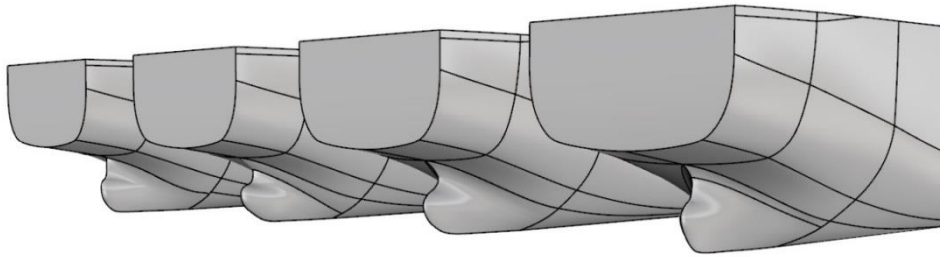


Hull optimization on different aspects like:

- ✓ Resistance of the ship
- ✓ Still water or any sea state
- ✓ Bare hull or complete hull with appendages
- ✓ Bossing and struts that affect the velocities field at the propeller plane
- ✓ Complete overview of the propulsive coefficients









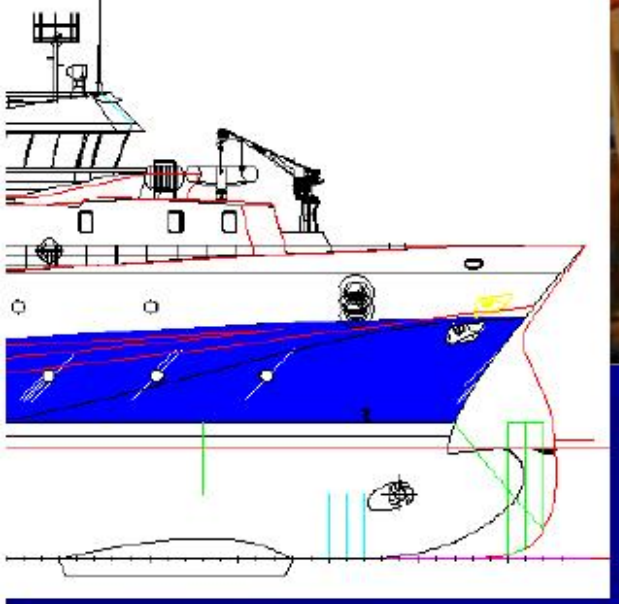


HIDRODINAMICS IN RESEARCH VESSELS: FORWARD BODY EVOLUTION

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

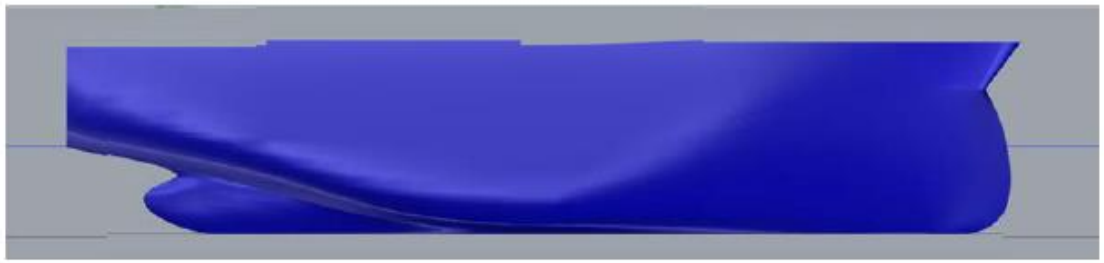
INSTITUTO ESPAÑOL DE OCEANOGRAFÍA

Evolución Proa



Proa corta el agua en vez de empujarla

CASCO TIPO 3 (identificado siempre con el color azul):







CASCO TIPO 4 (identificado siempre con el color naranja):

OPERATIONAL PROFILE IN A TYPICAL FRV:

- TRANSIT SPEED: 12-13 Kn
- TRAWLING: 3-6 Kn.
- SEABED MAPPING OR "FISH FINDING": 7-10 Kn.
- STATIONARY: DP POSITION

- ✓ VERTICAL PROFILE WITH A VERY CLOSE ANGLE OF WATER ENTRY
- ✓ THE SHIP GENTLY CUTS THROUGH THE WATER.
- ✓ VERY GOOD BUBBLE SWEEP DOWN BEHAVIOUR
- ✓ BOW FLARE IN TOP BOW AREAS TO PROTECT THE SUPERESTRUCTURE

MULTIBEAM ECHOSOUNDERS ARRANGEMENT : THE GONDOLA EVOLUTION

EXCELLENT ACOUSTIC PERFORMANCE

"BUBBLE SWEEP DOWN"

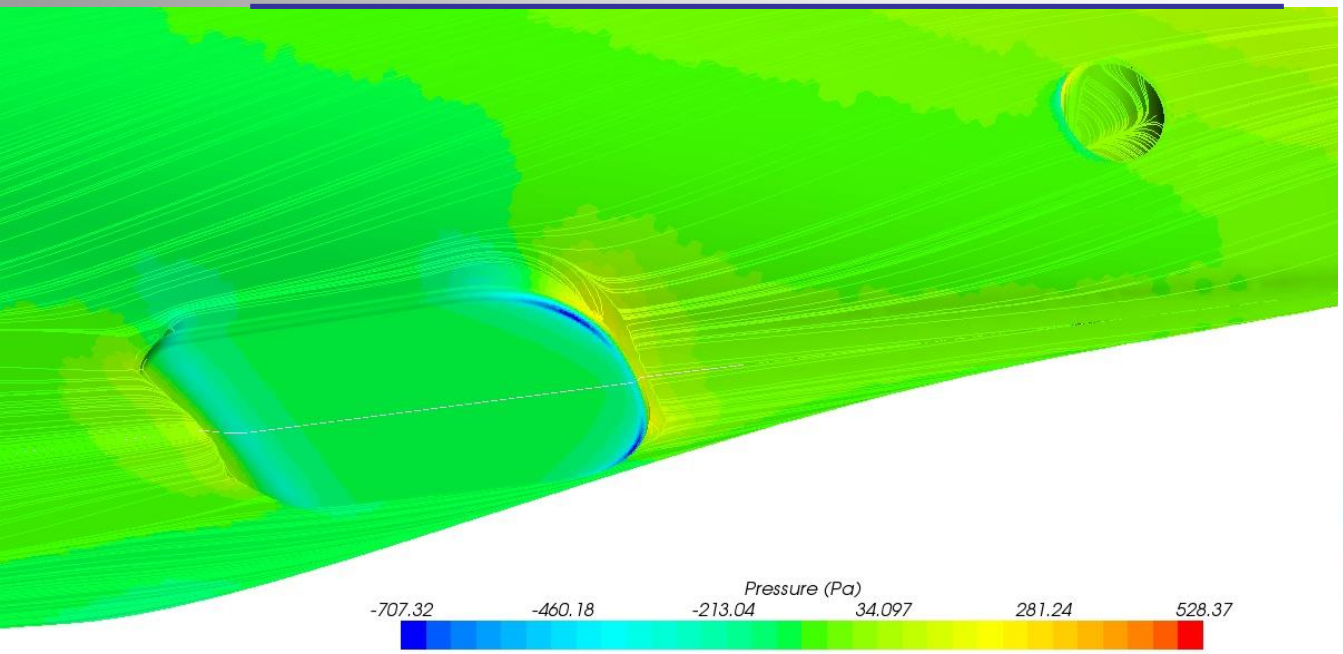
ITEMS TO IMPROVE

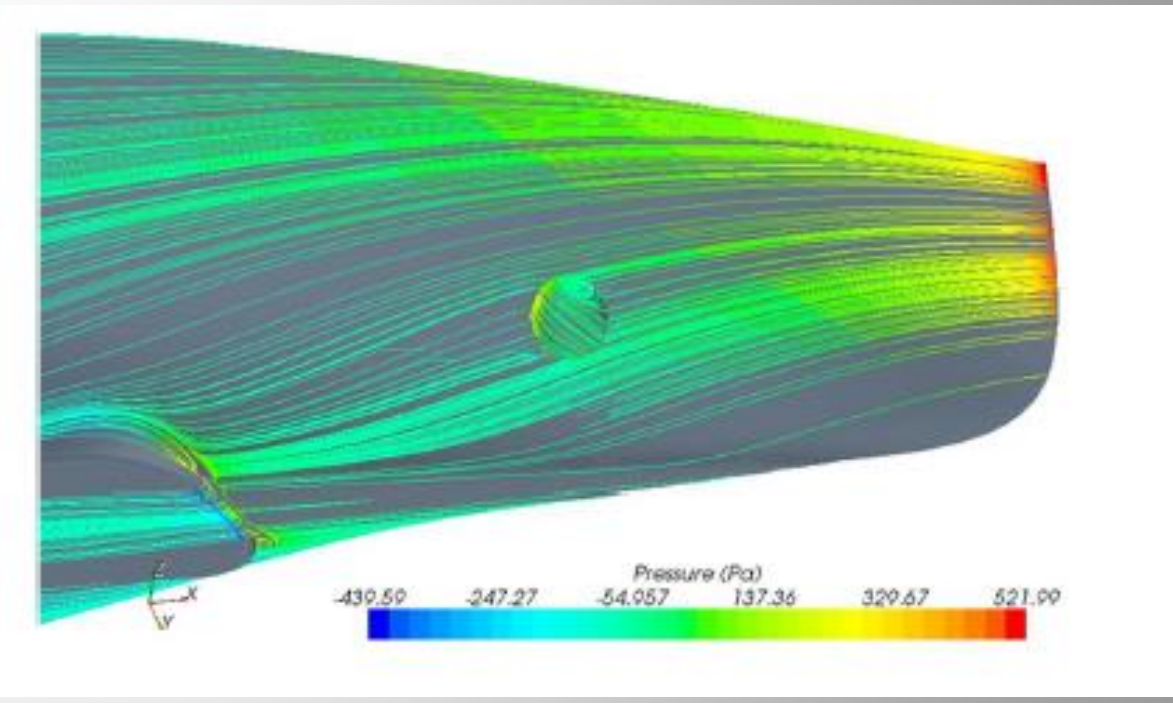
- ✓ HIGH HULL RESISTANCE: HIGHER CONSUMPTION
- ✓ DIMINISHED MANOEUVRABILITY: DIFFICULT TO KEEP COURSE MAINLY IN SMALL/MEDIUM SHIPS.
- ✓ HIGH DRAFT INCREASE:
  - Reduces operation in shallow waters
  - Makes the drydocking difficult

ARMON / VICUS CFD:

NEW GONDOLA DESIGN

STREAMLINES ASSESMENT





DIFFERENTIAL PRESSURE STUDIES TO CHECK BUBBLE DETACHMENT

ARMON GONDOLA DEVELOPEMENT:

- **EXCELLENT ACOUSTIC PERFORMANCE**

"BUBBLE SWEEP DOWN FROM ECHOSOUNDERS"

ARMON GONDOLA DEVELOPEMENT:

- CHALLENGES SOLVED

✓ HULL RESISTANCE REDUCTION:
REDUCED FUEL CONSUMPTION

✓ LOWER IMPACT IN SHIP MANOEUVRABILITY.

✓ LOWER DRAFT INCREASE (MAX. 150 mm):
- Improves operation in shallow waters
- Makes the drydocking easier

✓ INCREASED STRUCTURAL STRENGTH:
- Gondola adapted to ship bottom structure

✓ EASY ACCESS TO TRANSDUCERS: through the ship bottom tanks

UTM
UNIDAD DE TECNOLOGÍA MARINA

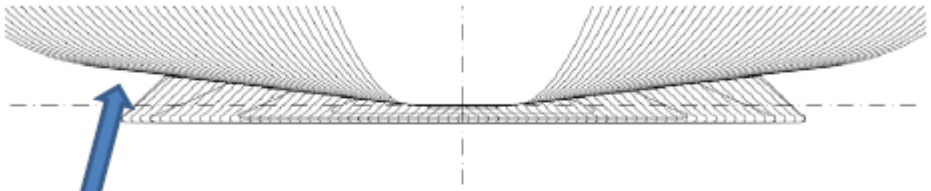
ARMON

CSIC

INSTITUTO ESPAÑOL DE OCEANOGRAFÍA 1914

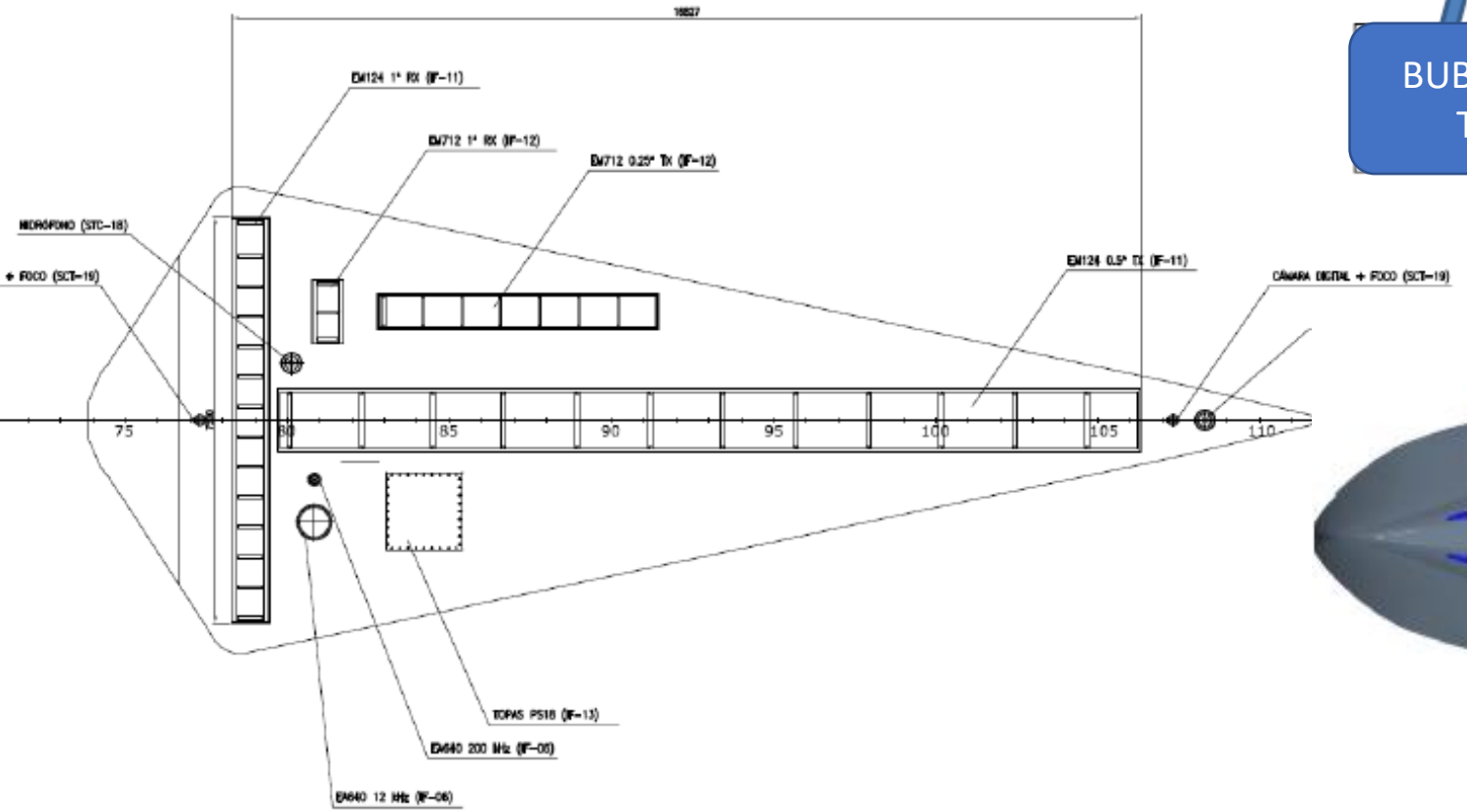
CASE STUDY: BOMAG. IMPLEMENTATION OF AN EM124 FOR A FULL SEABED COVERAGE. GONDOLA DIMENSIONS: APPROX. 20X10

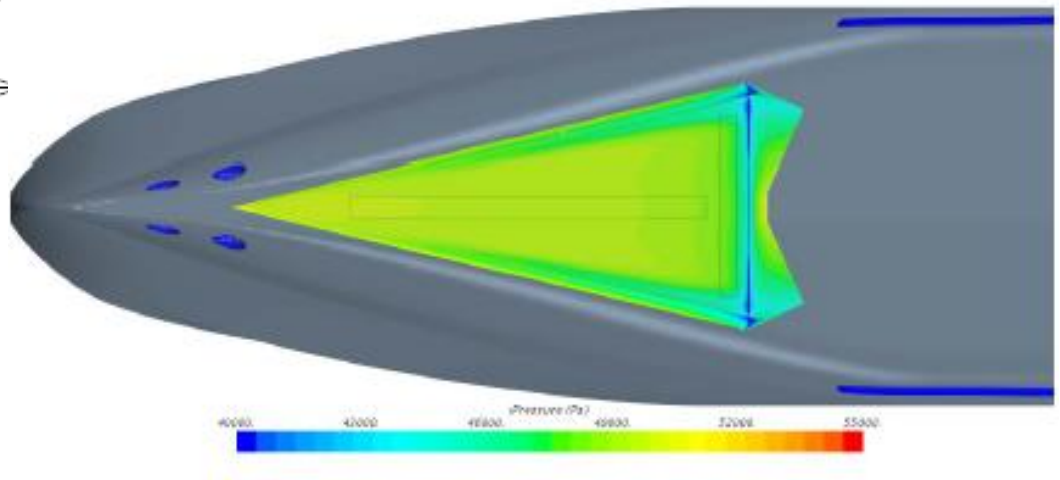
Detalle de la roda del buque y la integración de la góndola al casco.



Detalle de las formas de la góndola y su integración al casco

BUBBLES PATH SURROUNDING THE TRANSDUCER AREA





The ODON DE BUEN gondola in CEHIPAR towing tank facilities

AFT BODY OPTIMIZATION: WAKE FIELD OPTIMISATION

AFT BODY WITHOUT BULB

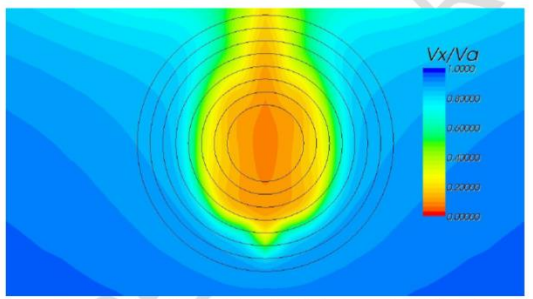
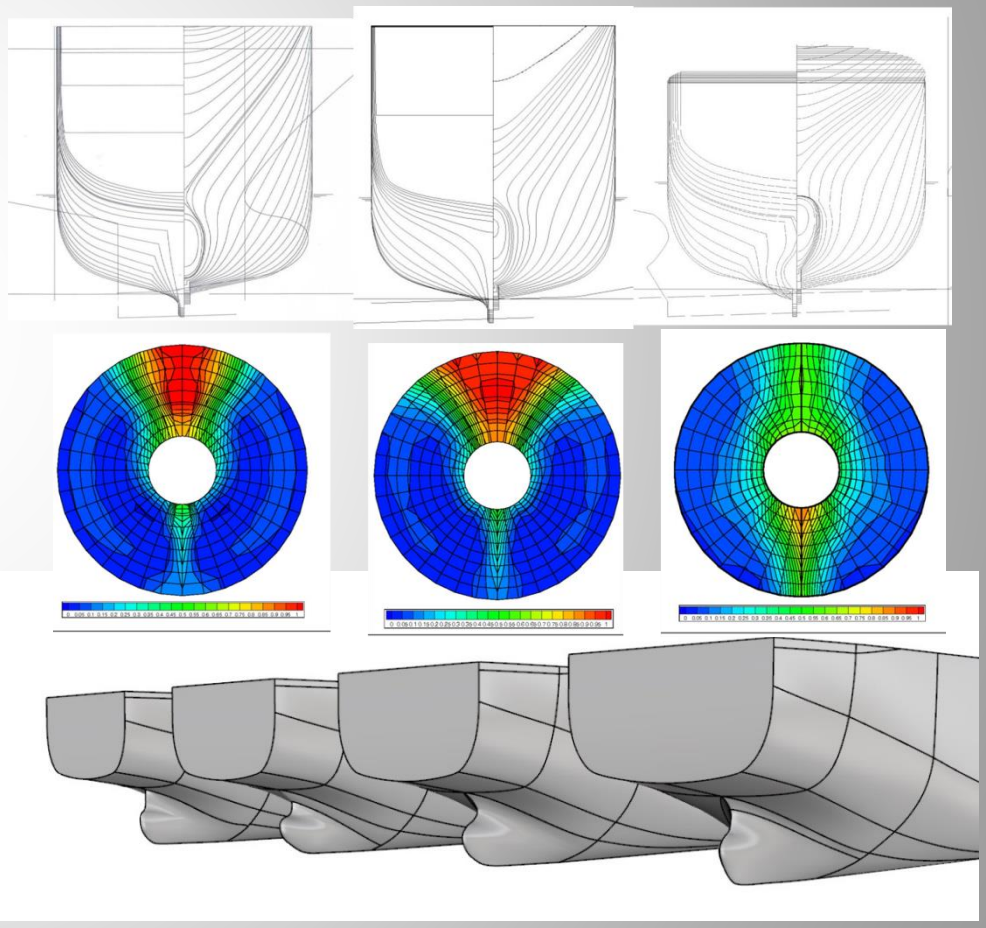


Figura 10: Estela axial. Velocidades locales vx adimensionalizadas con la velocidad del buque Va.

Como se puede observar en las figuras 11, 12 y 13, la estela no tiene una muy buen uniformidad, presentando unas zonas de velocidad alta en la parte alta del disco, con vx/Vs por debajo de 0,2. Esto representa un problema para los radios por encima de 0.7, que es la zona más susceptible de problemas para un diseño de propulsor libre de cavitación a 11 nudos. Otro aspecto a mejorar es la pendiente de las curvas en los radios exteriores, que deberían ser suavizadas para mejorar la dinámica de las fluctuaciones de presión en la pala.

VICUSdt
DESARROLLOS TECNOLÓGICOS



ARMON/ VICUS OPTIMISED BULB

Finalmente se calcula la estela modificada, en las curvas isoestela de vx/Vs se puede observar una mayor uniformidad y una notable aumento del caudal de agua en la zona alta el disco.

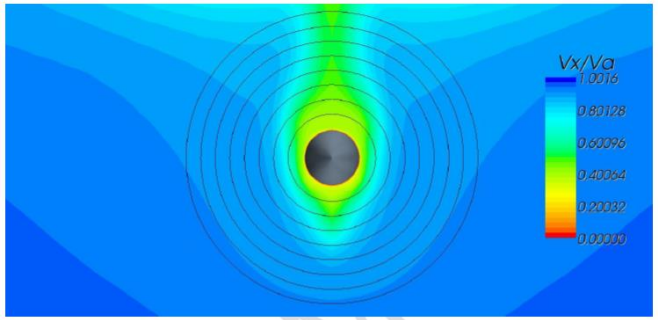


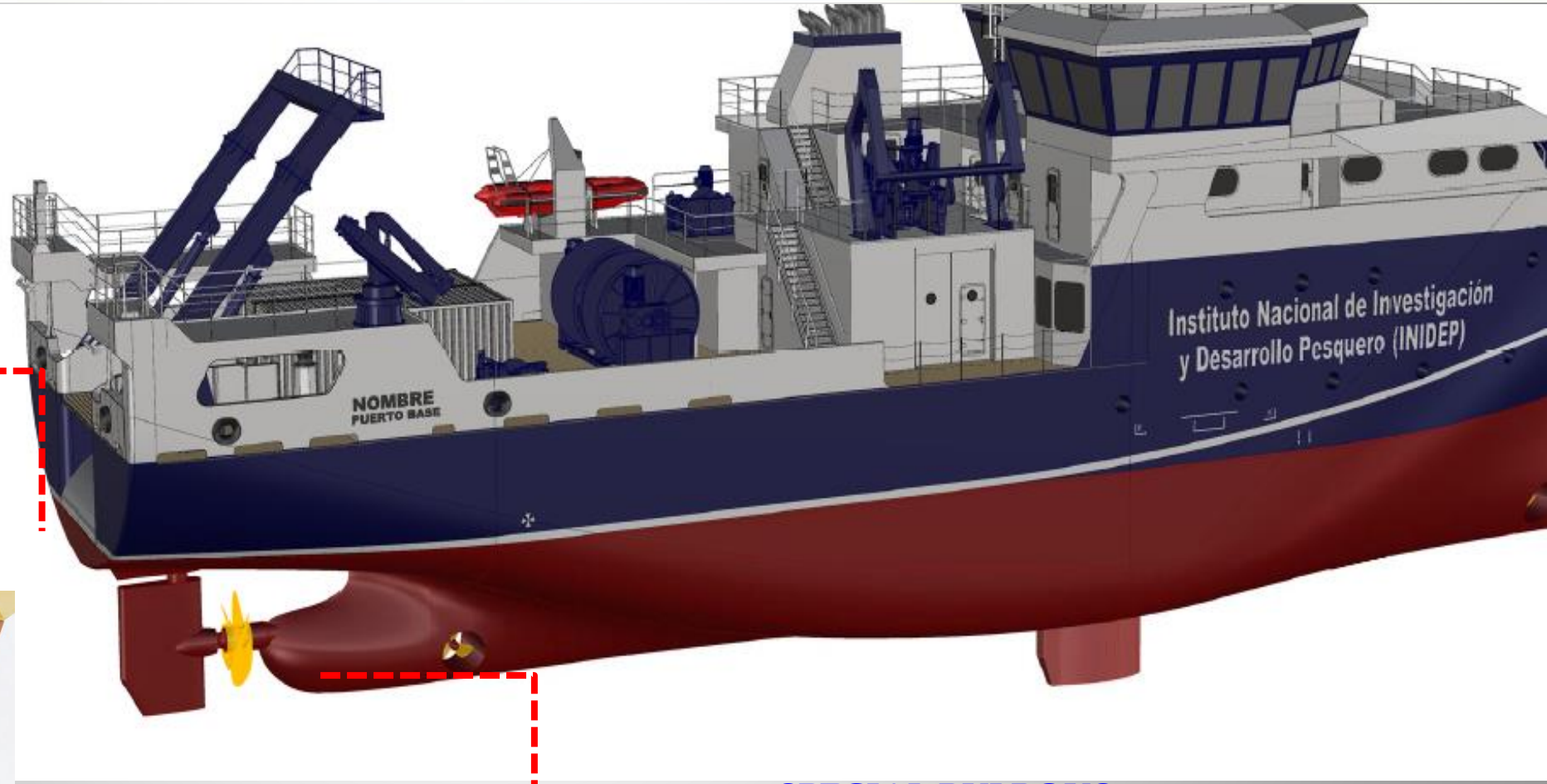
Figura 19: Estela axial de la carena modificada





HULL AFT BODY ENLARGED TO GAIN DECK FREE SURFACE AND SEPARATING THE PROPELLER FROM THE FISHING GEAR

Skipsteknisk



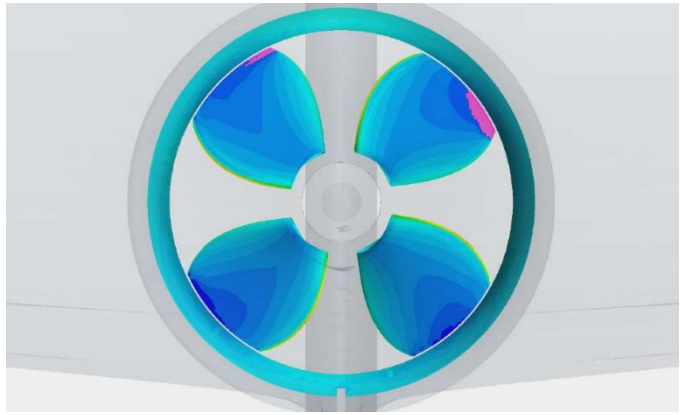
SPECIAL BULBOUS DESIGN FOR PROPELLER

SEPARATING THE PROPELLER FROM THE SHADOW OF THE HULL

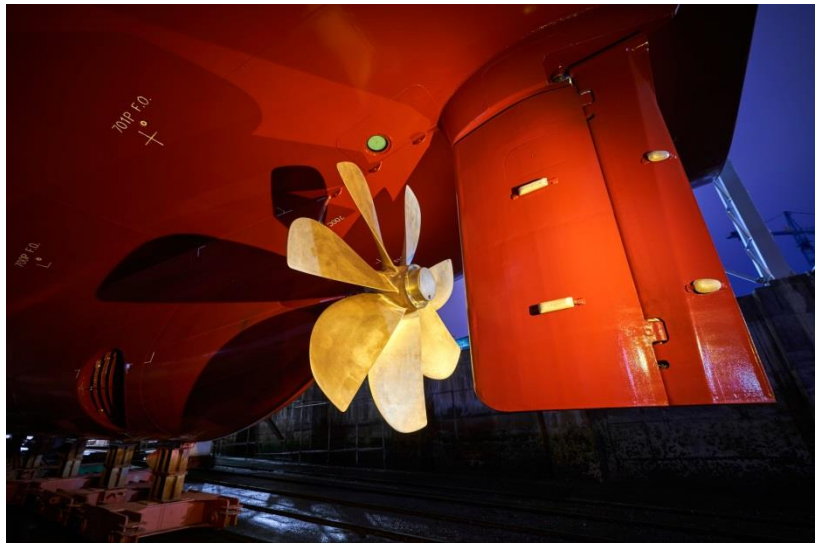
CFD COMBINED WITH TVI FROM DNV

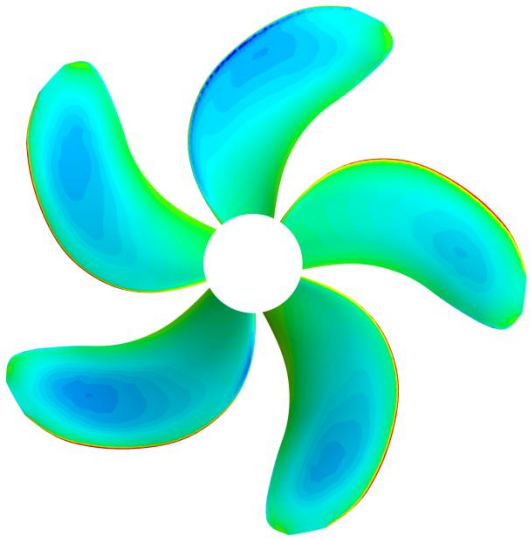
9 - SILENT PROPELLER DESIGN

- ✓ Cavitation calculation during the design state so it is eliminated or minimized within an acceptable limit leading to silent propellers
- ✓ Pressure pulses over the hull can also be determined with this methodology
- ✓ Tip vortex inception
- ✓ Face cavitation can be a problem due to tip unloading



Tip Vortex Index (TVI) Technique for Propeller Noise Estimation

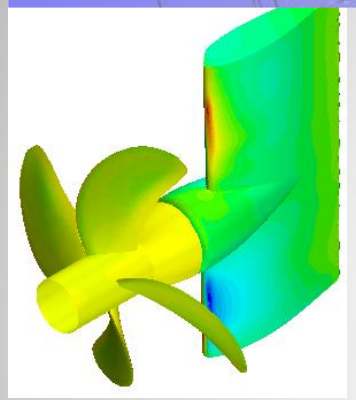
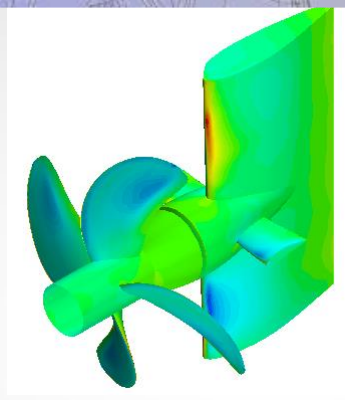








• El adecuado diseño de la hélice garantiza un bajo nivel de los pulsos de presión inducidos por esta en el casco y disminuye, por tanto, el riesgo de vibraciones

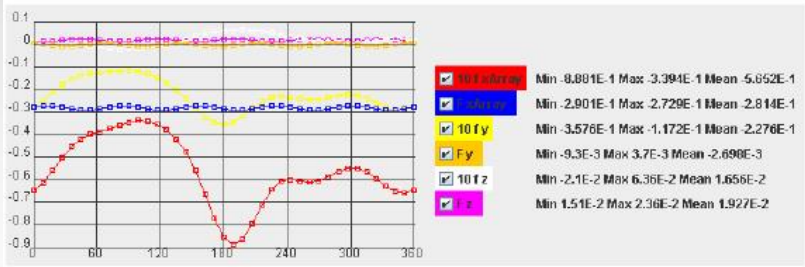


Fig.9 Fuerzas a 11.5kts

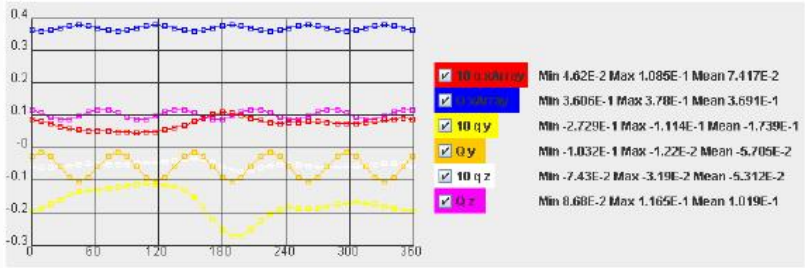


Fig.10 Momentos a 11.5kts

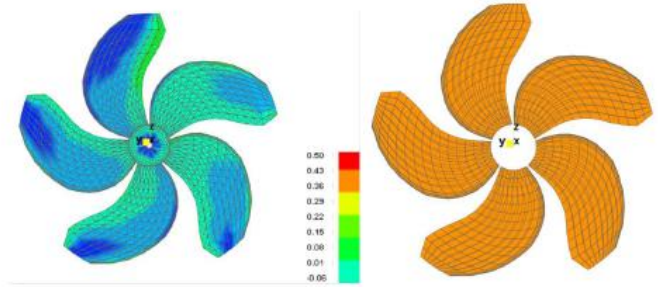
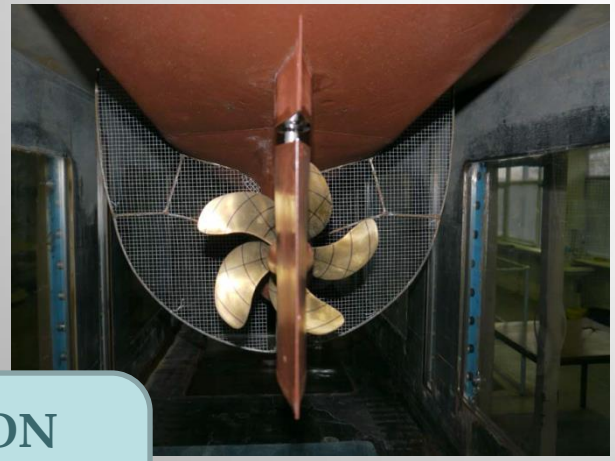


Fig.11 Cp / Cavitación a 11.5kts



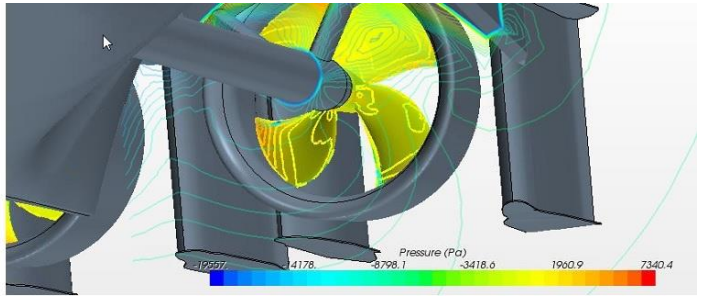
CAVITATION TANK TESTS FACILITIES

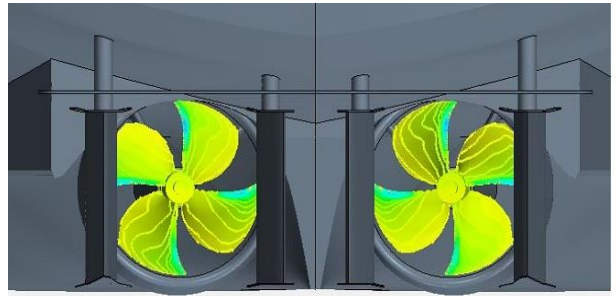
NEW DESIGN OF BULBOUS AFT BODIES APPLIED TO LAST GENERATION RESEARCH VESSELS

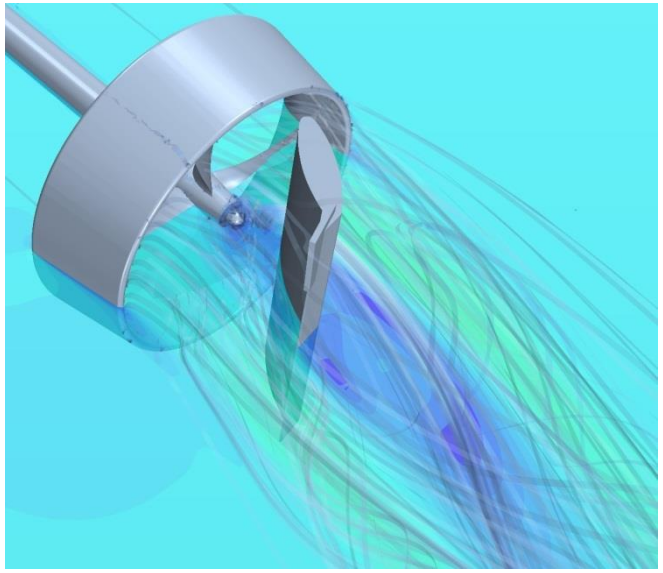
SHIP MANOEUVERING

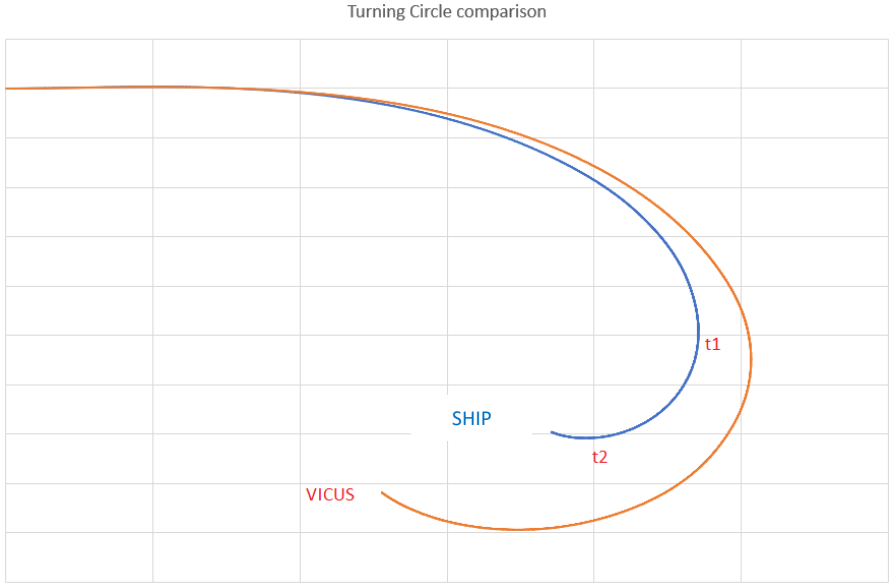
10 - RUDDER DESIGN & MANOEUVERING

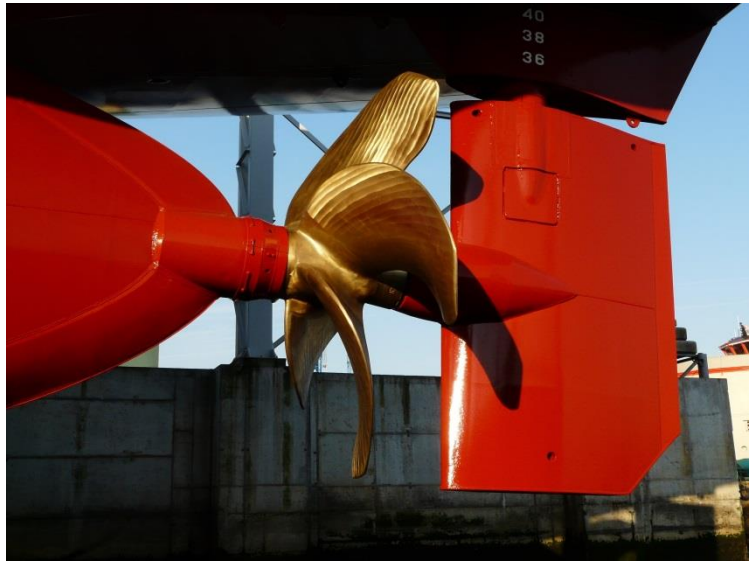
- ✓ Optimization on self propulsion
- ✓ Free run – fuel efficiency
- ✓ Maneuvering
- ✓ Twisted rudders with bulb
- ✓ Course stability on small L/B vessels







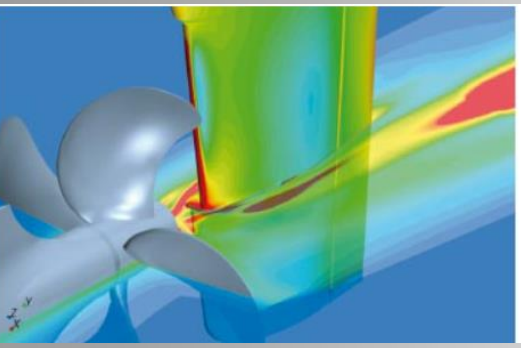
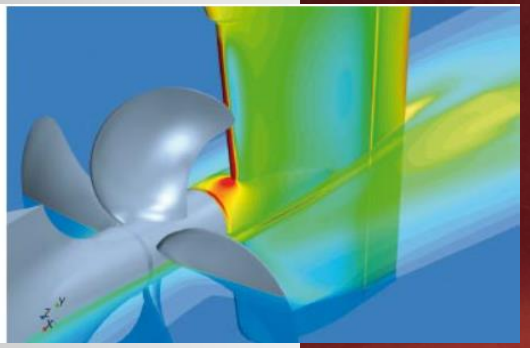




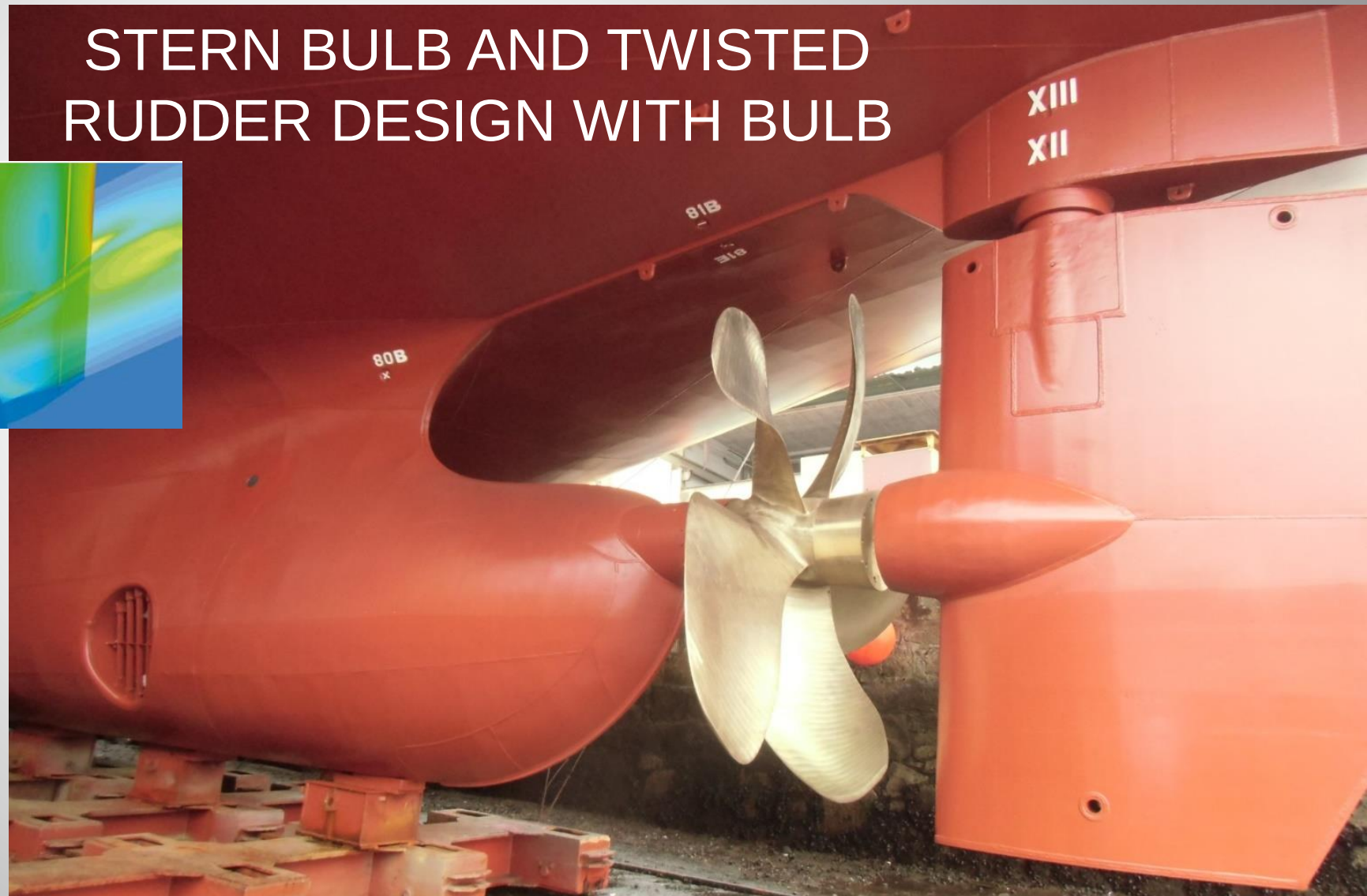




Vicus and Becker CFD ASSESMENT for a twisted bulb rudder

STERN BULB AND TWISTED RUDDER DESIGN WITH BULB



RUDDER WITH BULB:

- ✓ Minimises energy losses behind the propeller hub by eliminating flow separation and reducing wasteful fluid turbulence
- ✓ Optimal energy recovery from the propeller slipstream
- ✓ Reduccion of drag forces in the rudder

HEIGHT REDUCTION OF THE TRANSOM AND STERN RAMP:

1.-IMPROVES FISHING GEAR LIFT IN.

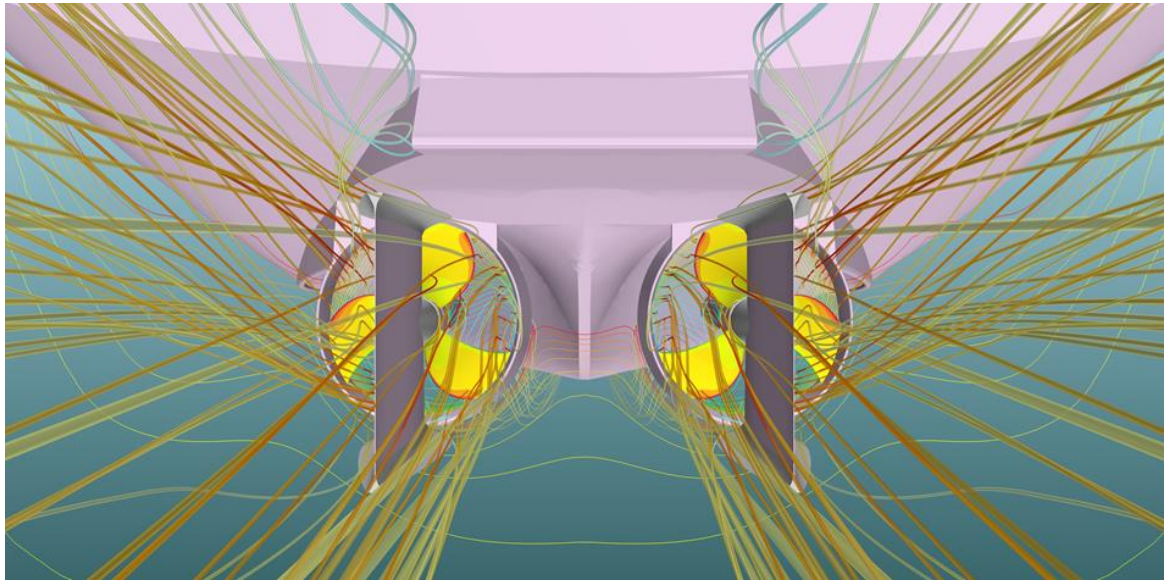
2.- AFT BODY DAMPING TO REDUCE HEAVE MOTION.

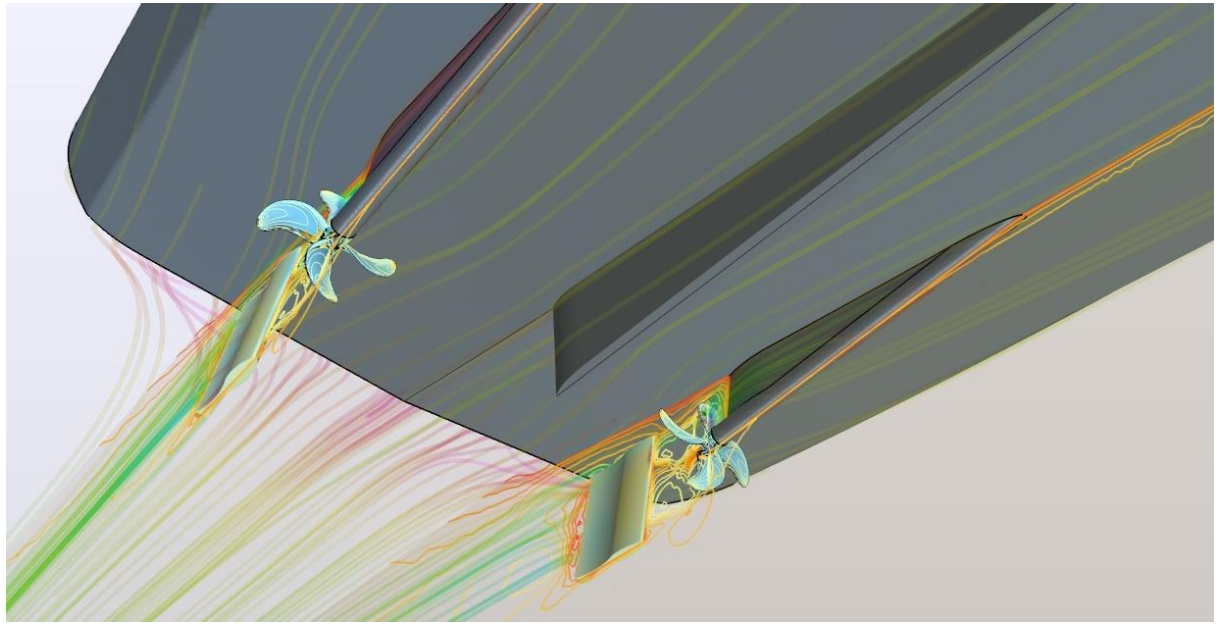
3.- LARGER LATERAL SURFACE TO REDUCE

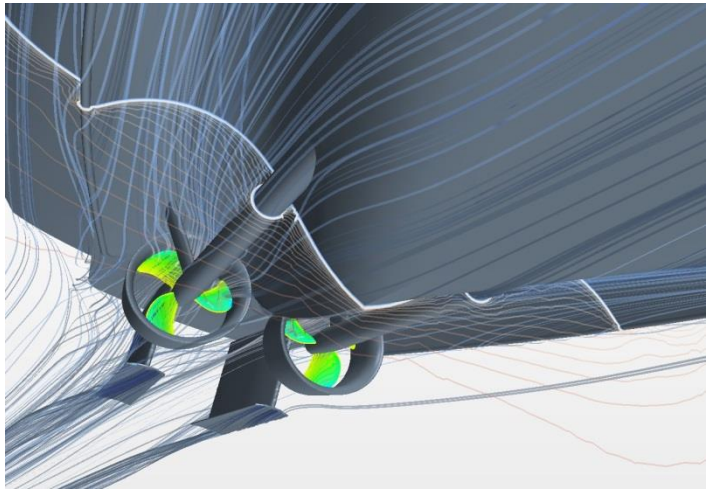
SHIP PROPULSION

8 - SELF-PROPULSION & TOW PULL ANALYSIS

- ✓ Effective wake coefficients
- ✓ Thrust deduction
- ✓ Rotative-relative efficiency
- ✓ Overall propulsion performance
- ✓ Iterative optimization hull-propeller-rudder



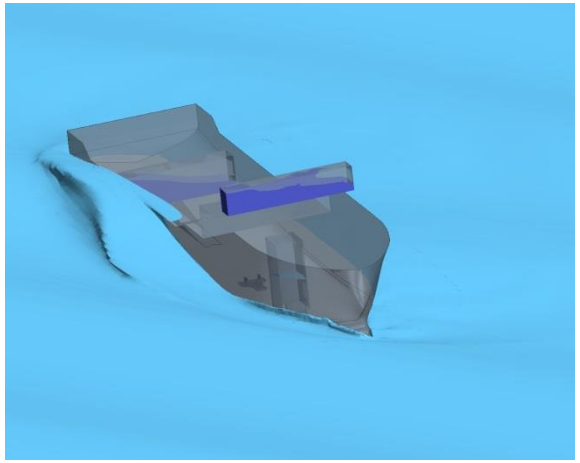


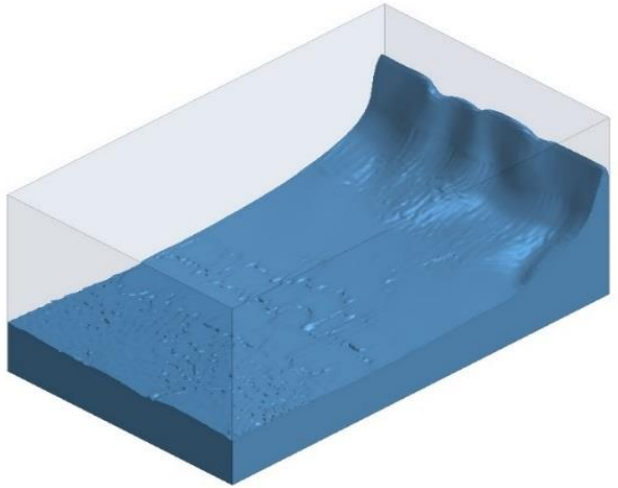


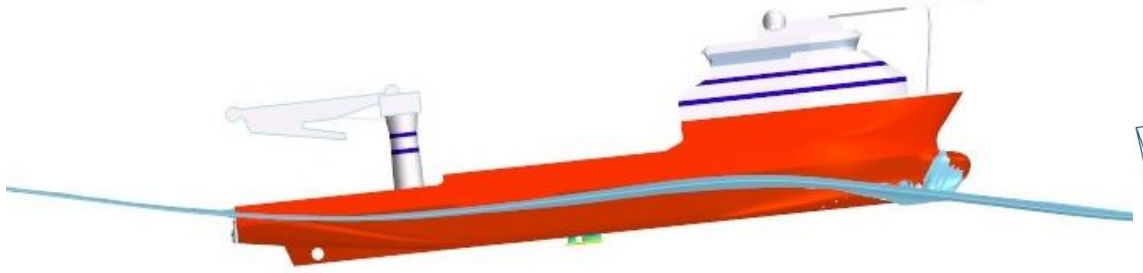
HYDRODYNAMICS: SEAKEEPING AND ANTI ROLLING TANKS

6 – SEAKEEPING & SLOSHING

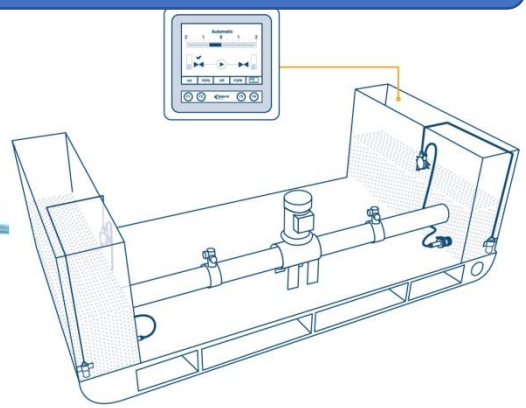
- ✓ Wave impact
- ✓ Lifting operations
- ✓ Ship dynamic model with several degrees of freedom
- ✓ Coupled calculation with structural analysis
- ✓ Green water
- ✓ Coupled seakeeping with antirolling tank effect
- ✓ Sloshing study for LNG tanks
- ✓ Accelerations based on preliminary seakeeping analysis
- ✓ RAOs
- ✓ Wall pressure fields assessment

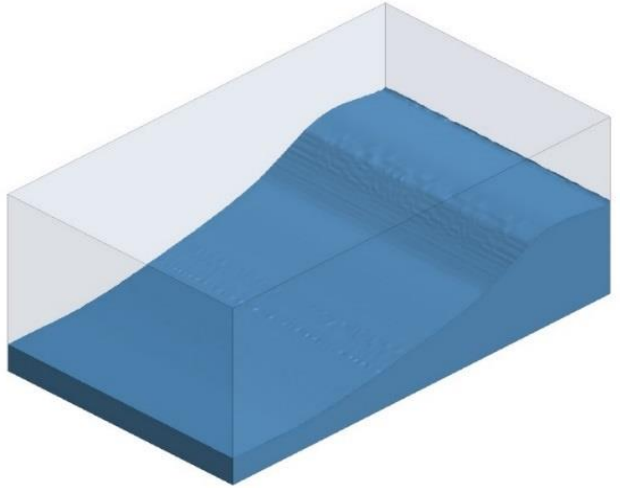






HOPPE ANTIHEELING TANK

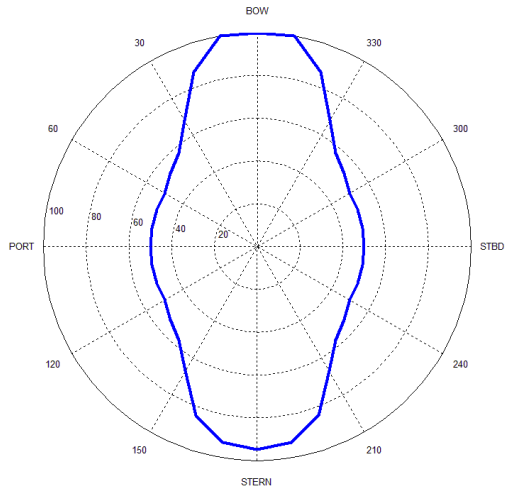


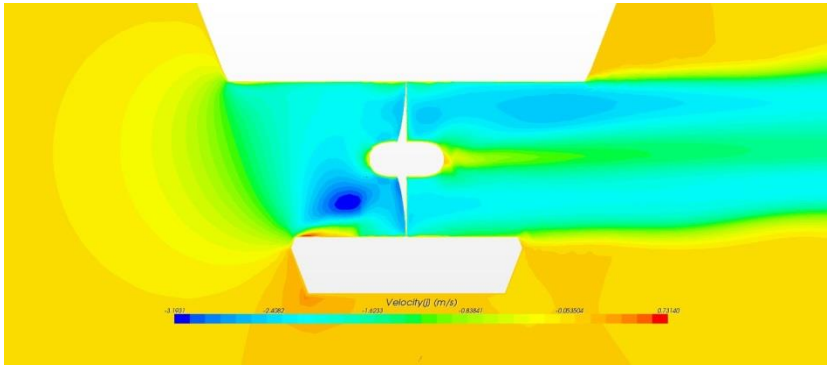


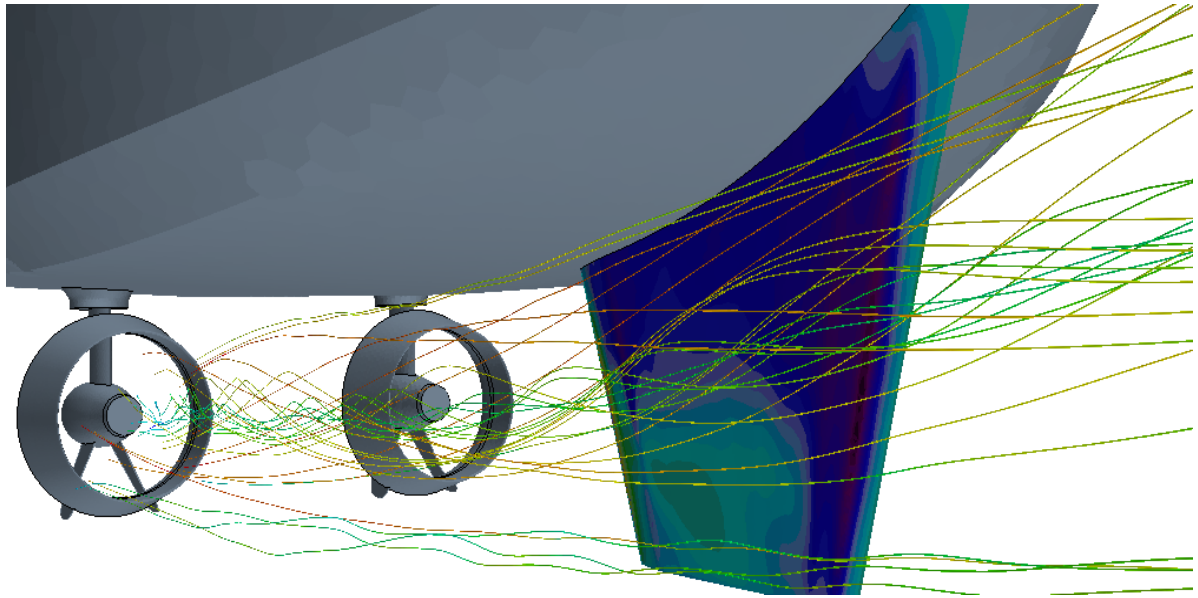
SHIP PROPULSION

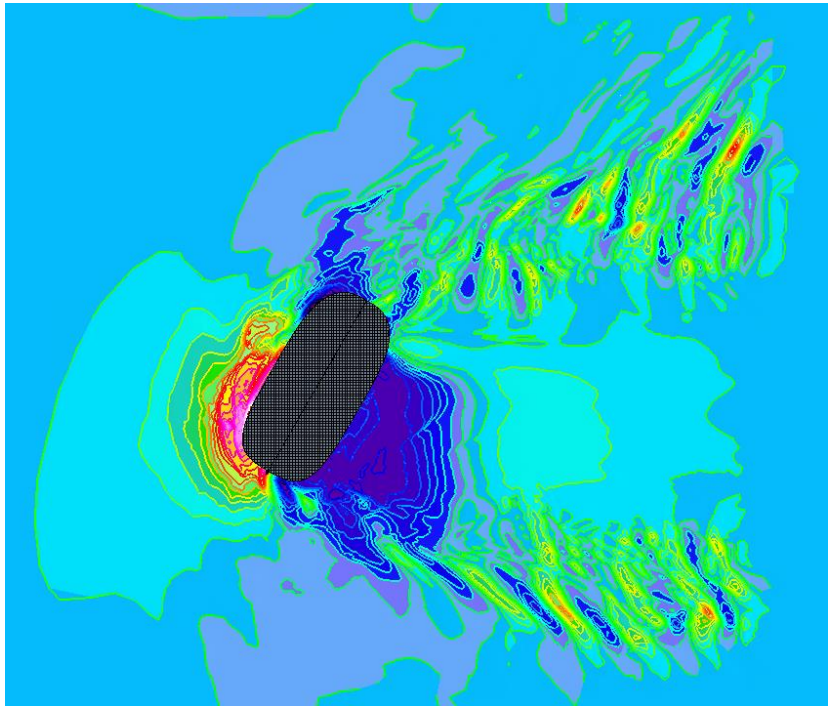
7 - DP ANALYSIS & THRUSTERS

- ✓ Turning circle
- ✓ Tactical diameter
- ✓ Speed loss on turning
- ✓ DP capability
- ✓ Crawling - docking





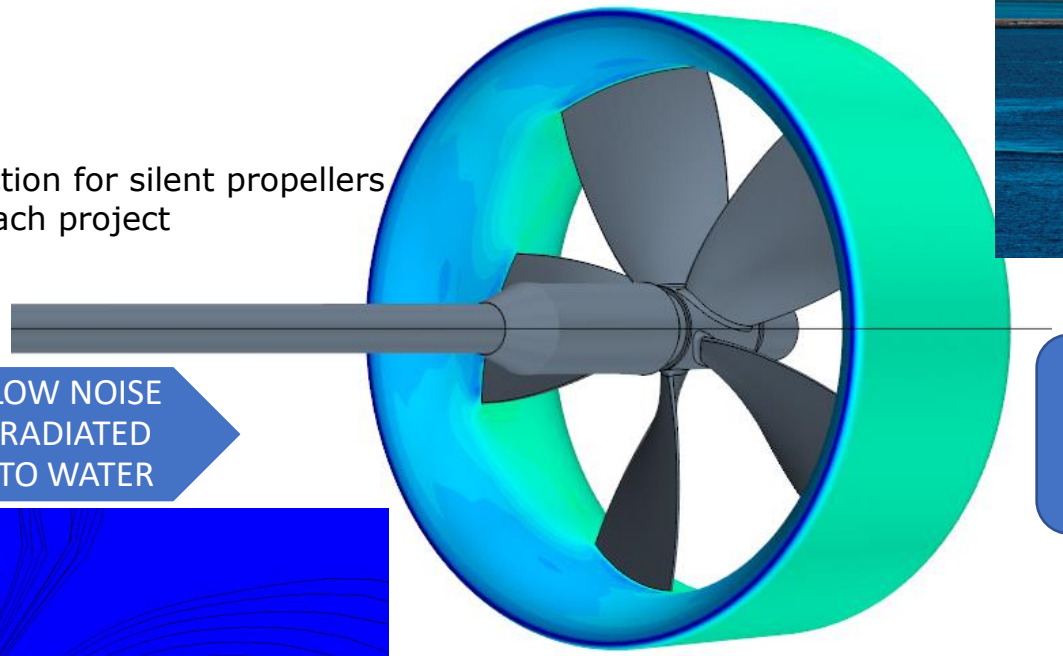




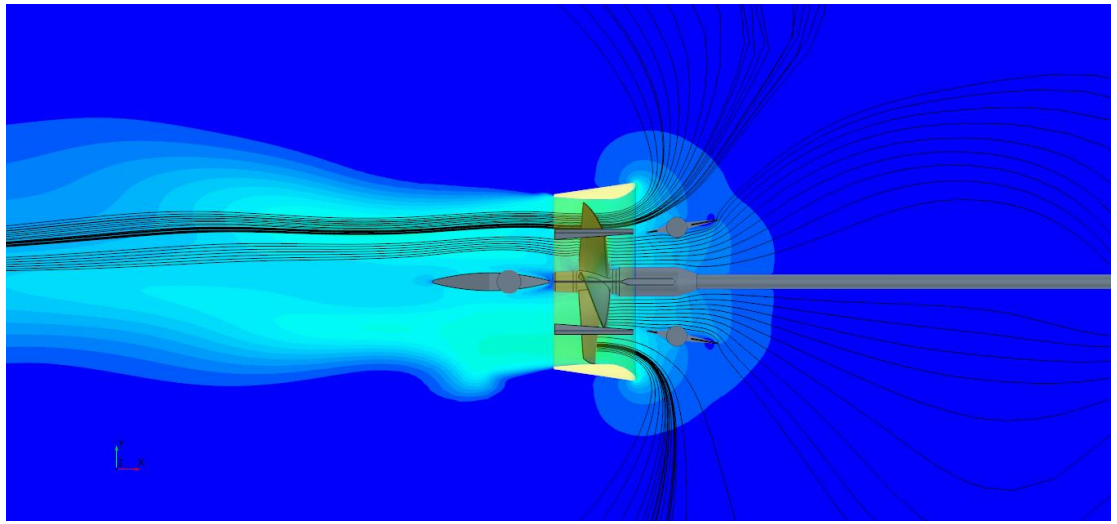
ARMON NEW FISH RESEARCH VESSELS: THE NOZZLE CHALLENGE

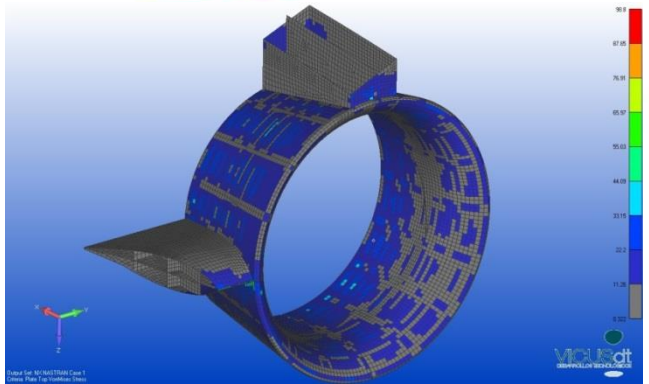
11 – SPECIAL NEW NOZZLE PROFILE DESIGN

- ✓ Nozzle design and optimization
- ✓ CFD & FEM calculations
- ✓ Hydrodynamic & Structural analysis
- ✓ Challenges on propeller nozzle interaction for silent propellers
- ✓ Special profiles and L/D tailored for each project



THRUST → PROPELLER EFFICIENCY → LOW NOISE RADIATED TO WATER





NEW FRV FOR HAFRO ICELAND

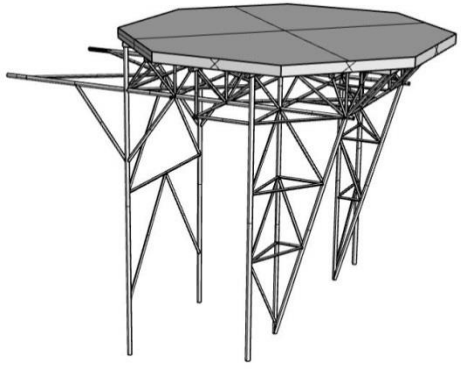
NEW FRV FOR NIWA NEW ZELAND

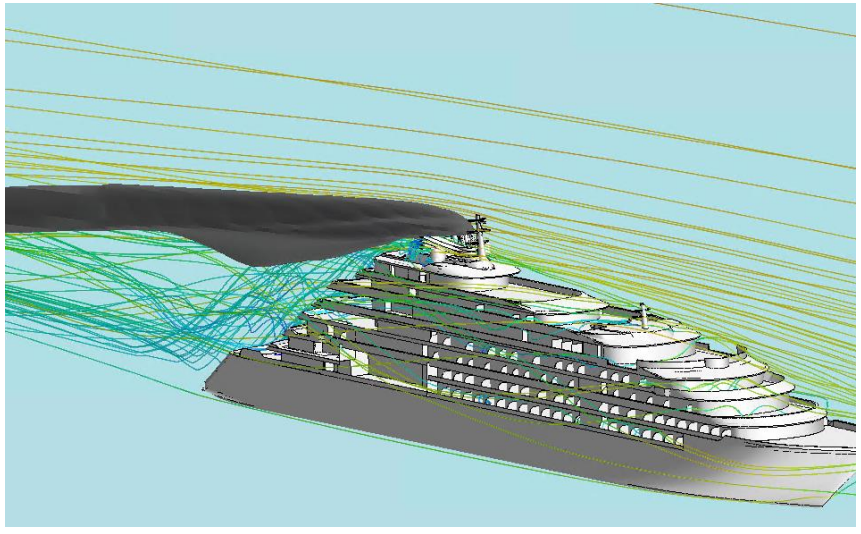
Skipsteknisk

AERODYNAMICS

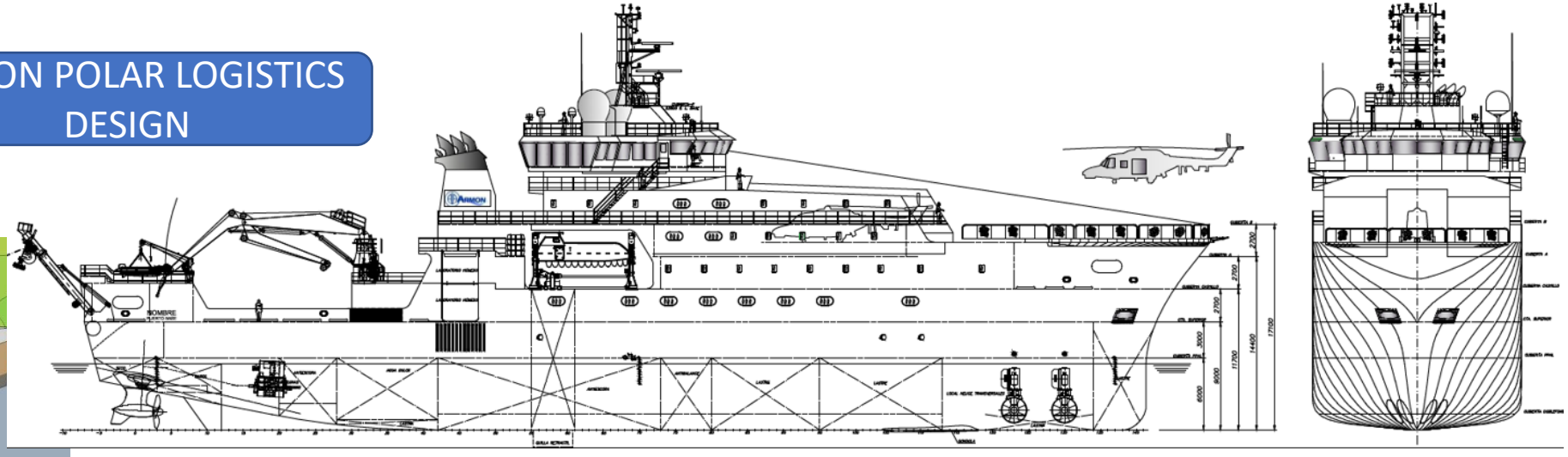
12 - AERODYNAMICS EXHAUST GAS, HVAC & HELIDECKS

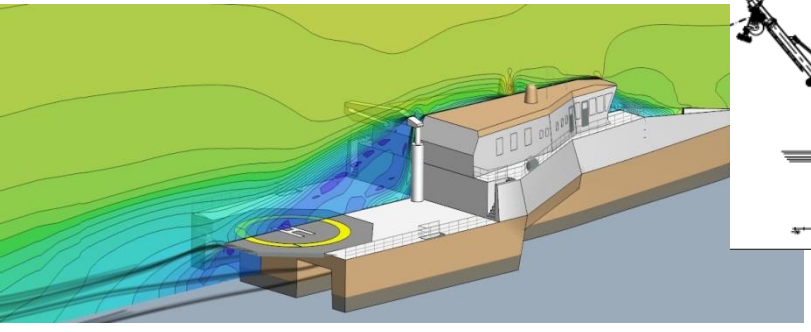
- ✓ Thermal plume dispersion
- ✓ Helideck (NORSOK C-004)
- ✓ Exhaust gas flow analysis
- ✓ Smoke dispersion
- ✓ Comfort criteria balconies
- ✓ DP Calculations





ARMON POLAR LOGISTICS DESIGN





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