V CONGRESO INTERNACIONAL DE DISEÑO E INGENIERÍA NAVAL

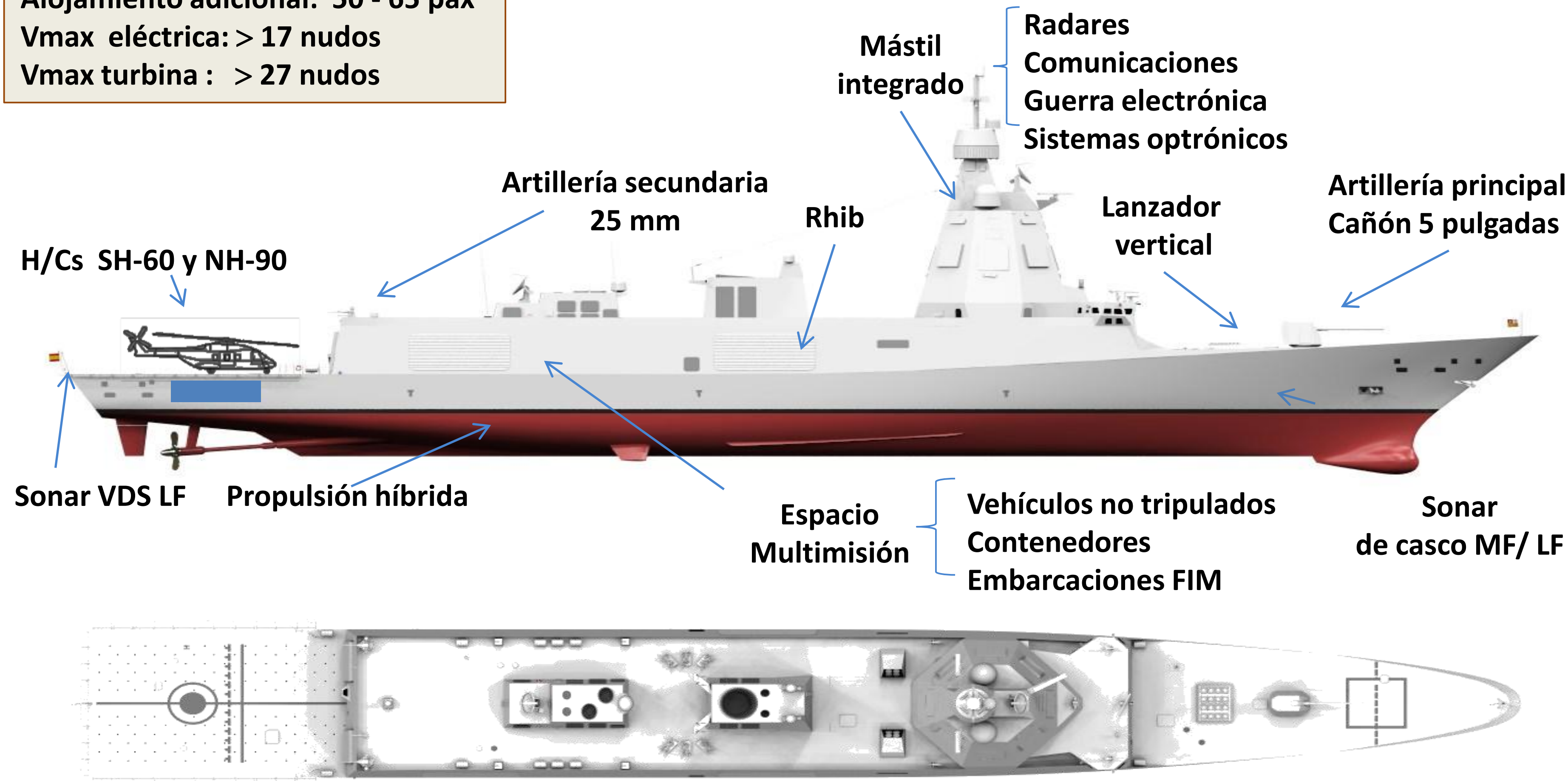
Marzo 15 - 17 de 2017

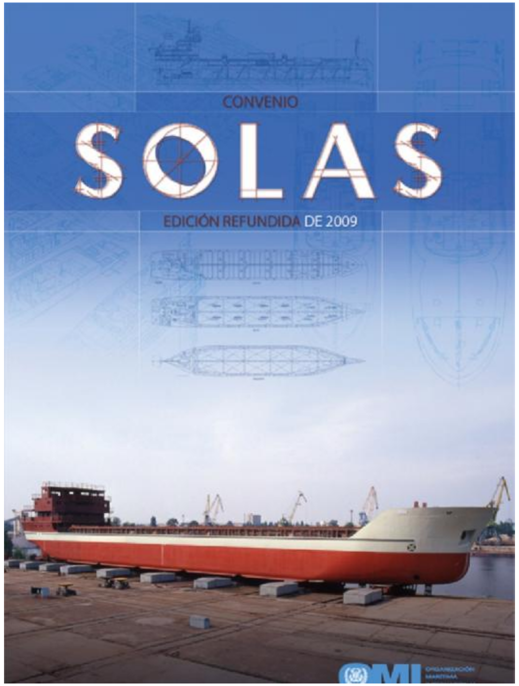
CF José María Riola

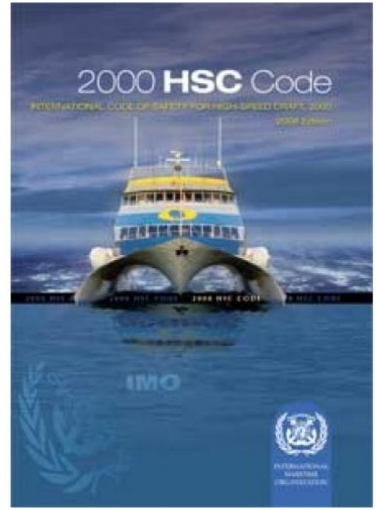
PhD Naval Architect

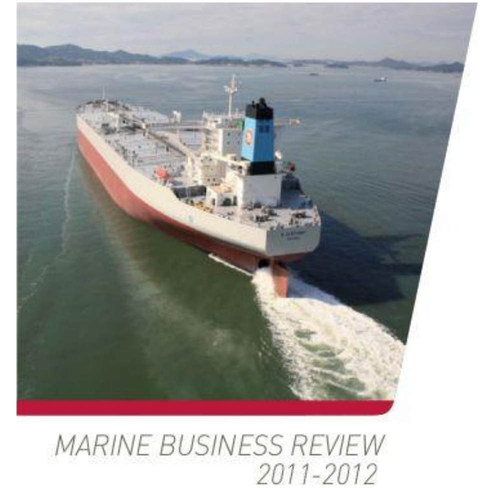
FRAGATA F-110
Diseño preliminar

Dotación reducida: 150 pax
Alojamiento adicional: 50 - 65 pax
Vmax eléctrica: > 17 nudos
Vmax turbina : > 27 nudos





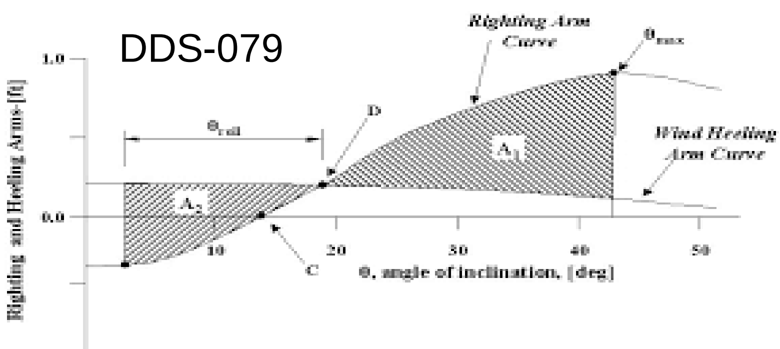




Move Forward with Confidence

General Specifications for Ship

DDS-079



Rules for the Classification of Naval Ships

NR 483

AMENDMENTS

July 2014

NATO STANDARD

ANEP-77

NAVAL SHIP CODE

Edition E Version 1

JANUARY 2014

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED NAVAL ENGINEERING PUBLICATION

Littoral Combat Ship (US Navy)

- USS FREEDOM Class
- 3 vessels (LCS-1, LCS-3, LCS-5)

- USS INDEPENDENCE Class
- 3 vessels (LCS-2, LCS-4, LCS-6)

Joint High Speed Vessel

- USS SPEARHEAD ClasS 11 vessels

DDG 1000 (United States Navy)

- USS ZUMWALT Class Destroyer
- 2 vessels (DDG-1000, DDG-1001)

ESTUDIO DE EVACUACIÓN: NORMATIVAS

NATO STANDARD

ANEP-77

NAVAL SHIP CODE
Edition F Version 1

AUGUST 2014

NORTH ATLANTIC TREATY ORGANIZATION

ALLIED NAVAL ENGINEERING PUBLICATION

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SIN CLASIFICAR

D-CP-09

MANUAL DE DOCTRINA DE MANIOBRA Y NAVEGACIÓN

SIN CLASIFICAR

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4 ALBERT EMBANKMENT
LONDON SE1 7SR

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IMO

E

Ref. T4/4.01

MSC.1/Circ.1238
30 October 2007

GUIDELINES FOR EVACUATION ANALYSIS FOR NEW AND EXISTING PASSENGER SHIPS

1 The Maritime Safety Committee, at its seventy-first session (19 to 28 May 1999), having approved MSC/Circ.909 on Interim Guidelines for a simplified evacuation analysis of ro-ro passenger ships as a guide for the implementation of SOLAS regulation II-2/28-1.3, requested the Sub-Committee on Fire Protection (FP) to also develop guidelines on evacuation analysis for passenger ships in general and high-speed passenger craft.

2 The Committee, at its seventy-fourth session (30 May to 8 June 2001), following a recommendation of the forty-fifth session of the FP Sub-Committee (8 to 12 January 2001), approved MSC/Circ.1001 on Interim Guidelines for a simplified evacuation analysis of high-speed passenger craft. The Committee, at its eightieth session (11 to 20 May 2005), after having considered a proposal by the forty-ninth session of the Sub-Committee on Fire Protection (24 to 28 January 2005) made in light of the experienced gained in the application of the aforementioned Interim Guidelines, approved MSC/Circ.1166 on Guidelines for a simplified evacuation analysis of high-speed passenger craft, which supersede MSC/Circ.1001, together with the worked example appended thereto.

3 The Committee, at its seventy-fifth session (15 to 24 May 2002), further approved MSC/Circ.1033 on Interim Guidelines on evacuation analyses for new and existing passenger ships and invited Member Governments to collect and submit to the Sub-Committee on Fire Protection for further consideration, any information and data resulting from research and development activities, full-scale tests and findings on human behaviour which may be relevant for the necessary future upgrading of the present Interim Guidelines.

4 The Committee, at its eighty-third session (3 to 12 October 2007), approved the Guidelines on evacuation analyses for new and existing passenger ships, including ro-ro passenger ships, as set out in the annexes to the present circular.

5 The annexed Guidelines offer the possibility of using two distinct methods:

.1 a simplified evacuation analysis (annex 1); and/or

.2 an advanced evacuation analysis (annex 2).

6 The assumptions inherent within the simplified method are by their nature limiting. As the complexity of the vessel increases (through the mix of passenger types, accommodation types, number of decks and number of stairways) these assumptions become less representative of reality. In such cases, the use of the advanced method would be preferred. However, in early design iterations of the vessel, the simplified method has merit due to its relative ease of use and its ability to provide an approximation to expected evacuation performance.

I:\CIRC\MSC\01\1238.doc

maritimeEXODUS v5.1

THEORY MANUAL

BY

E.R. GALEA, P.J. LAWRENCE, L. FILIPPIDIS, D. BLACKSHIELDS, D. COONEY and G. SHARP

maritimeEXODUS
the evacuation model for the maritime industry

August 2014
Revision 1.0

aritimeEXODUS is a product of GUEL, a subsidiary of the University of Greenwich.

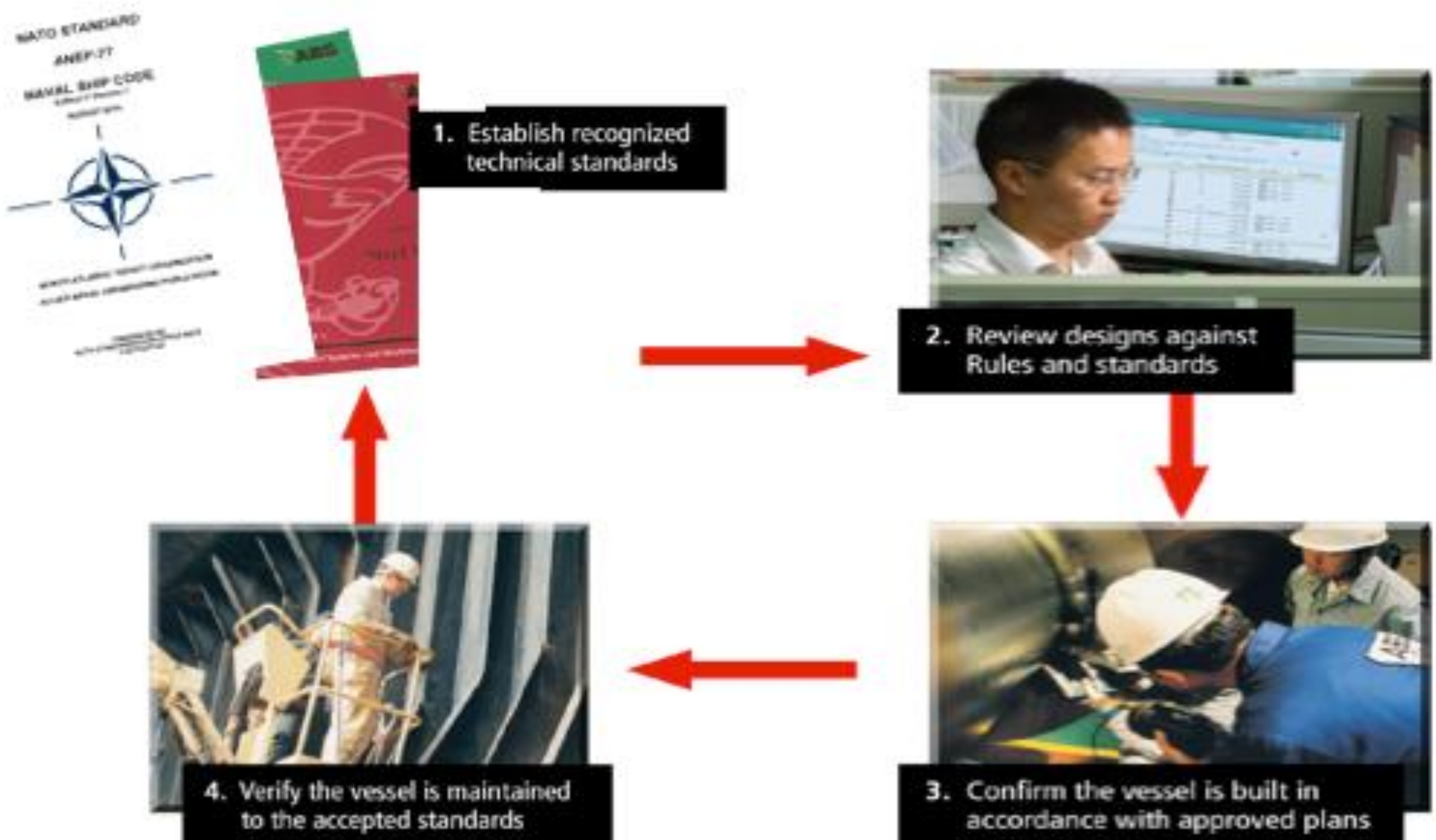
Fire Safety Engineering Group
University of Greenwich
London SE10 9LS
UK

FSEG

WINNER OF
T AWARDS 2001
BCS
HE BRITISH COMPUTER SOCIETY

The Guardian University Awards
Winner 2014

Ciclo del Proceso Integrado



The Naval Ship Code: A Goal-Based Standard

- Chapter I – General Provisions
- Chapter II – Structure
- **Chapter III – Buoyancy, Stability and Controllability**
- Chapter IV – Engineering Systems
- Chapter V – NOT USED
- Chapter VI – Fire Safety
- Chapter VII – Escape, Evacuation and Rescue
- Chapter VIII – Communications
- Chapter IX – Navigation and Seamanship
- Chapter X – Dangerous Goods
- ANNEX A – Guide to the Naval Ship Code

Serie de Fragatas F-110

4ª revolución industrial

Industria 4.0

Astillero 4.0


CONFIDENCIAL

Ministerio de Defensa

Armada

Estado Mayor de la Armada

VERSION 1

REQUISITOS DE ESTADO MAYOR

(REM)

FUTURO BUQUE DE ESCOLTA F-110

CONFIDENCIAL

ORIGINAL

Proyección

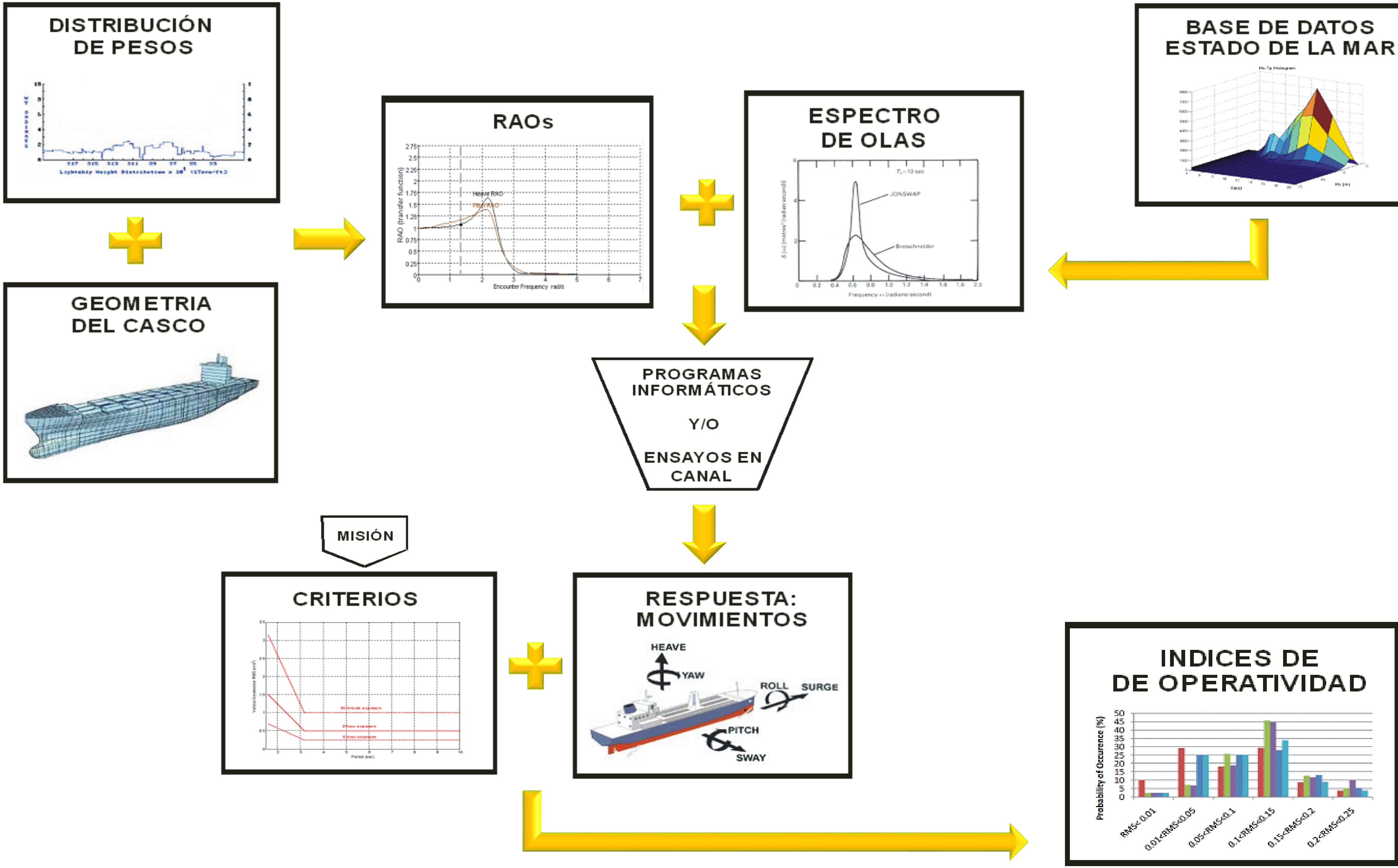
Protección

Libertad de Acción

Apoyo Logístico

Acción Marítima

Service	Description	Weather & Sea Characteristics	Survival & Rescue Infrastructure
Ocean Unlimited	Fully independent operation at sea, able to hold station in all but extreme conditions, able to resume duties after conditions abate	Severe tropical cyclone or equivalent, extreme winds and extreme seas.	Early rescue not likely. Probable extended period in survival mode.
Ocean Limited	Independent operation at sea, avoiding centres of tropical disturbance, able to resume duties when conditions abate	Storm force weather or equivalent. Very high winds and very high seas.	Early rescue not likely. Probable extended period in survival mode.
Offshore	Independent operation within 200 nautical miles or 12 hours at cruising speed (whichever is less) of a safe haven. Return to safe haven if winds likely to exceed Beaufort 8.	Gale force weather and very rough seas.	Survival in moderate conditions or early location likely and within helicopter range for rescue.
Restricted Offshore	Restricted operations within 4 hours travel at cruising speed of a safe haven.	Near gale force weather and rough seas.	Survival in benign conditions or early rescue.
Protected Waters	Operates within specified geographical limits or within 2 hours travel at cruising speed of a safe haven in waters specified as 'partially smooth'.	Strong breeze winds and moderate seas.	Rescue facilities and/or shoreline nearby.
Smooth Waters	Operates within specified geographical limits or within 1 hours travel at cruising speed of a safe haven in waters specified as 'smooth'.	Strong breeze winds and operates only in small waves.	Rescue facilities and/or shoreline nearby.

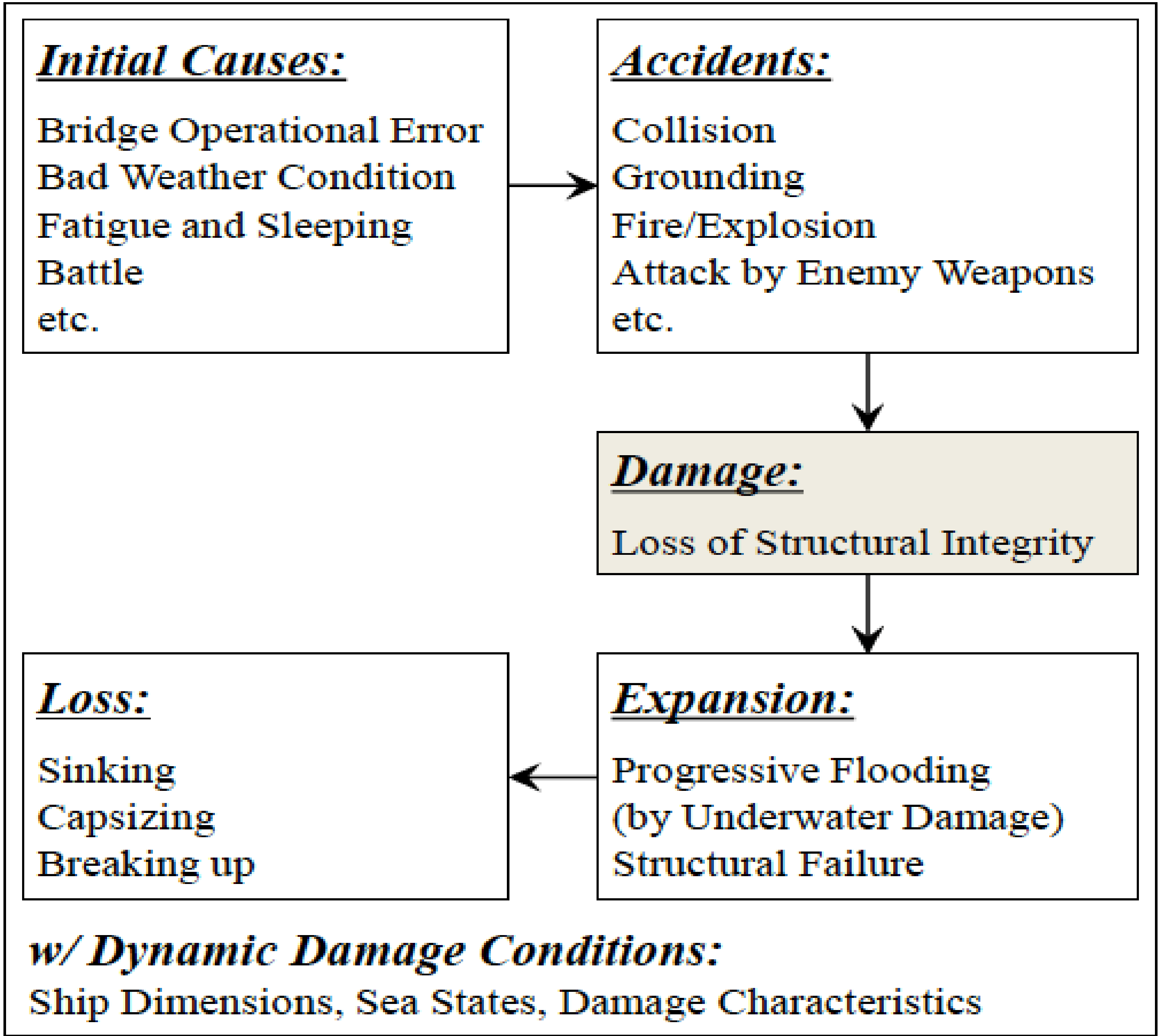

DISTRIBUCIÓN DE PESOS
GEOMETRIA DEL CASCO
RAOs
Heave RAO
Encounter Frequency rad/s
RAO (transfer function)
ESPECTRO DE OLAS
JONSWAP
Bretschneider
BASE DE DATOS ESTADO DE LA MAR
PROGRAMAS INFORMÁTICOS
Y/O
ENSAYOS EN CANAL
MISIÓN
CRITERIOS
RESPUESTA: MOVIMIENTOS
HEAVE
YAW
ROLL
SURGE
PITCH
SWAY
INDICES DE DE OPERATIVIDAD
Probability of Occurence (%)
RMS< 0.01
0.01<RMS<0.05
0.05<RMS<0.1
0.1<RMS<0.15
0.15<RMS<0.2
0.2<RMS<0.25

Estabilidad Intacta

Diferentes opciones de cálculo en función del tipo de buque, sus formas y su perfil operativo

Estabilidad en Averías

De obligado estudio. Incluye la definición de la supervivencia requerida de referencia


Initial Causes:
Bridge Operational Error
Bad Weather Condition
Fatigue and Sleeping
Battle
etc.
Accidents:
Collision
Grounding
Fire/Explosion
Attack by Enemy Weapons
etc.
Damage:
Loss of Structural Integrity
Expansion:
Progressive Flooding
(by Underwater Damage)
Structural Failure
Loss:
Sinking
Capsizing
Breaking up
w/ Dynamic Damage Conditions:
Ship Dimensions, Sea States, Damage Characteristics

Scenario	Damage Extent	Damage Location	Vulnerability	Post-damage Capability	Recovery Philosophy	Supplementary Notes
	DCA Limited DCB Moderate DCC Severe	DLI Internal DLSI Specific Internal DLE External DLS Side DLOB Outer Bottom	VB Basic VM Moderate VN Naval	PC1 Safe Abandonment PC2 Float and Move PC3 Operational	RPB Basic RPI Intermediate RPA Advanced	Relevant additional notes for clarification
#1	DCA	DLOB	VB	PC3	RPI	
#2	DCB	DLI	VN	PC3	RPI	
#3	DCB	DLSI	VN	PC2	RPI	Steering gear
#4	DCC	DLSI	VB	PC1	RPI	Main magazine and machinery space
Etc						

Estabilidad dinámica:

- Dynamic Rolling
- Parametric excitation
- Resonant excitation
- Impact excitation
- Transient flooding
- Broaching
- Porposing
- Sloshing
- Whipping
- …

Service Class	Operational			Survival			Damage		
	Wind Speed		Sig. Wave Height (m)	Wind Speed		Sig. Wave Height (m)	Wind Speed		Sig. Wave Height (m)
	Nominal (B'fort)	Design (knots)		Nominal (B'fort)	Design (knots)		Nominal (knots)	Design (knots)	
Ocean Unlimited	9	70	6.0	12	100	17.7	26	39	2.5
Ocean Limited	8	60	6.0	10	80	11.2	26	39	2.5
Offshore	7	50	4.0	8	60	6.2	24	36	2.2
Restricted Offshore	6	40	2.5	7	50	4.3	22	33	1.8
Protected Waters	5	30	1.25	6	40	2.5	20	30	1.5
Smooth Waters	5	30	0.5	6	40	0.8	20	30	0.5

Probability of Failure Occurrence	Member Failure Severity				
	Catastrophic	Critical	Significant	Marginal	Negligible
	1	2	3	4	5
Frequent (1)	**High** (Renew Immediately)				
Probable (2)					
Feasible (3)			**Serious** (Renew by end of next avail)		
Rare (4)				**Medium** (monitor annually)	
Improbable (5)					**Low** (monitor every 3 yrs)
Anomaly (6)					**Very Low** (no special attention)

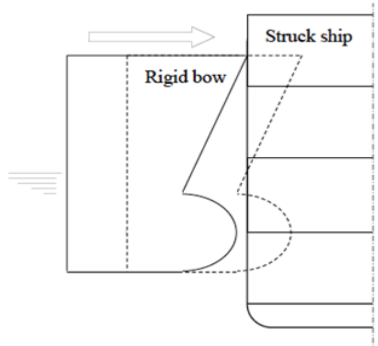
- Supervivencia: se describe en términos de susceptibilidad y vulnerabilidad
- Susceptibilidad: la habilidad de evitar la detección del enemigo
- Vulnerabilidad: se basa en su estabilidad, división e integridad estructural, estanqueidad…

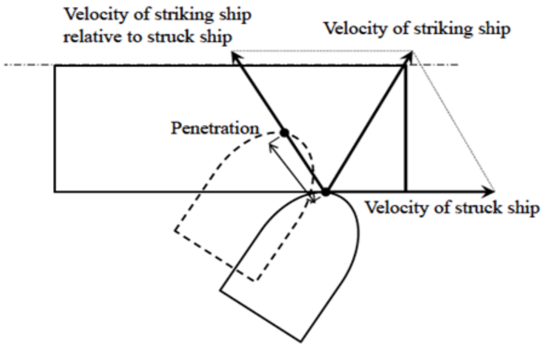
Para la efectiva aplicación del NSC se debe clarificar:

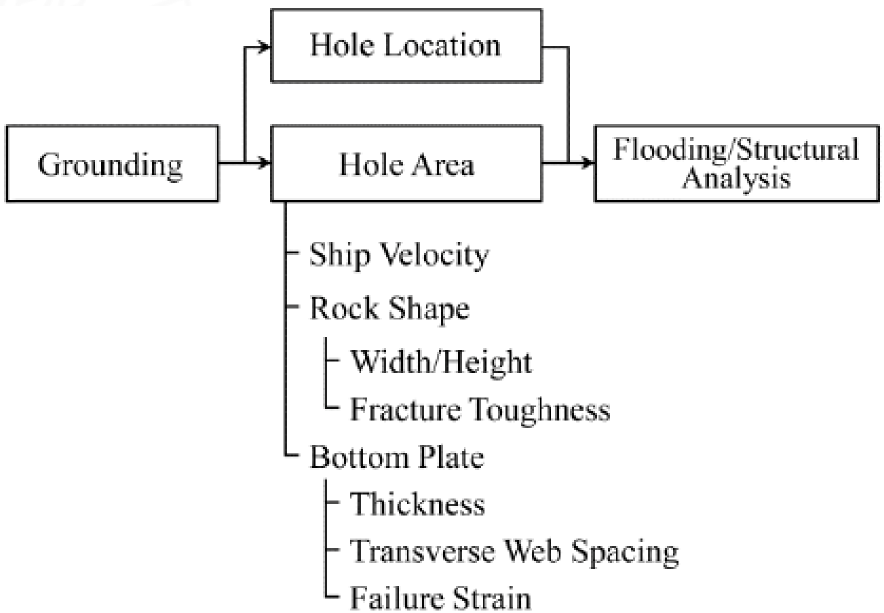
- La extensión y la localización del daño
- El grado de vulnerabilidad (protección, redundancia de sistemas, materiales usados…)
- La capacidad post-avería requerida
- La filosofía de recuperación desde el estado de avería
- El nivel de supervivencia establecido para cada tipo de buque

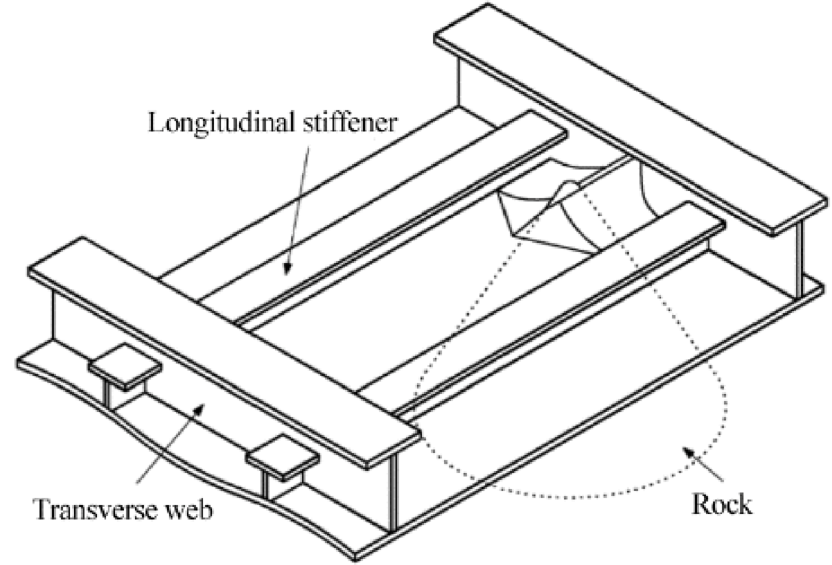
- Collision → Hole Location, Hole Area
- Hole Location, Hole Area → Flooding/Structural Analysis
- Environmental Condition → Flooding/Structural Analysis

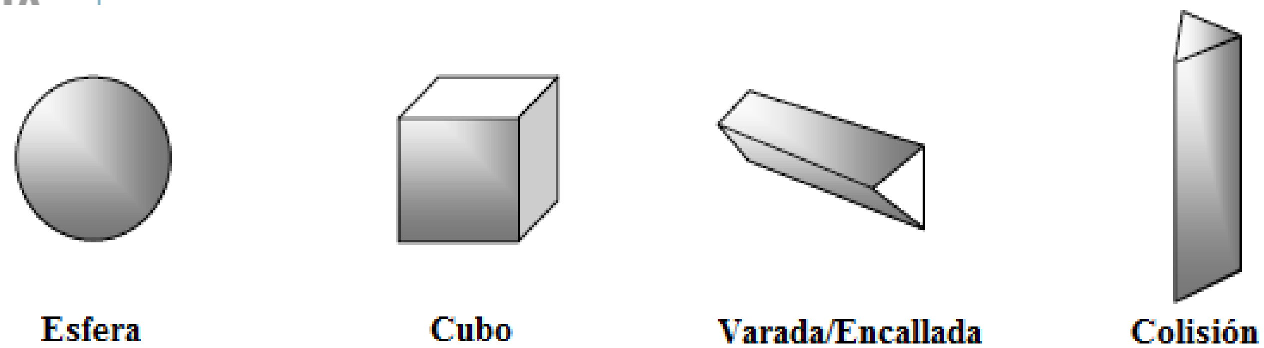
Hole Area
- Bow Geometry
  - Conventional Bow
    - Stem Angle
    - Breadth(Deck/Bottom)
    - Uppermost Deck Height
  - Bulbous Bow
    - Length of the Bulb
    - Vertical/Horizontal Radius of the Bulb
    - Distance Between the Bulb Tip to the Foremost Part of the Bow
- Penetration
  - Collision Angle
  - Velocity of the Striking Ship Relative to the Struck Ship






Hole Location
Grounding
Hole Area
Flooding/Structural Analysis
Ship Velocity
Rock Shape
Width/Height
Fracture Toughness
Bottom Plate
Thickness
Transverse Web Spacing
Failure Strain


Longitudinal stiffener
Transverse web
Rock



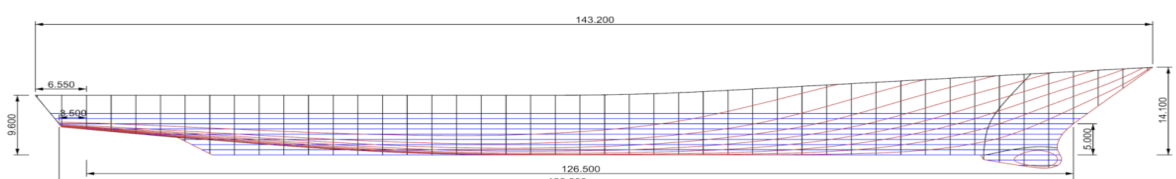
CARACTERÍSTICAS	DCA	DCB	DCC
Explosión (esfera)	1 m radio	4 m radio	10 m radio
Incendio (cubo)	2 m de arista	8 m de arista	20 m de arista
Varada (Prisma horizontal)	4 m largo 0,5 m lado triangulo	16 m largo 2 m lado triangulo	40 m largo 5 m lado triangulo
Colisión (Prisma Vertical)	4 m altura 0,5 m lado triangulo	16 m altura 2 m lado triangulo	40 m altura 5 m lado triangulo

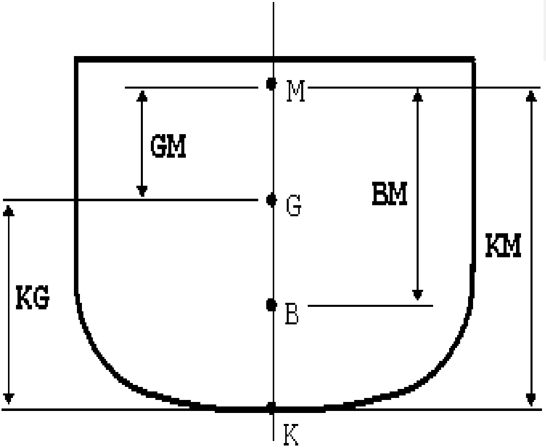
Categoría de daño C:

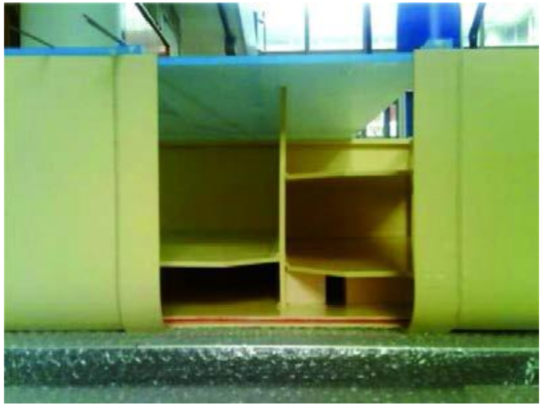
- Esfera de radio 10m
- Cubo de 20m de lado
- Varada de 40m de longitud y 5m a ambos lados
- Colisión de 40m de longitud y 5m a ambos lados

$\lambda = 40$

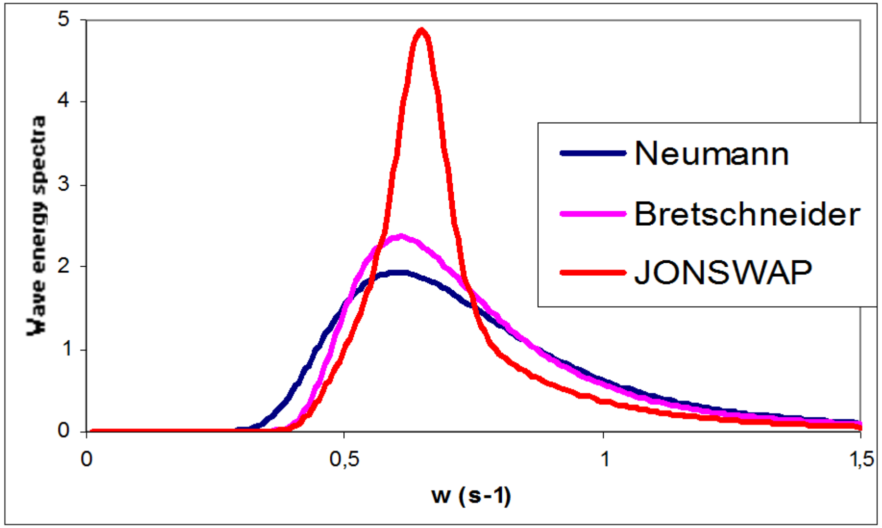
Quantity	Model	Prototype	Factor
Linear dimensions	1 m	40 m	λ
Areas	1 m^2	1600 m^2	λ^2
Volumes	1 m^3	64000 m^3	λ^3
Time	1 s	6.324 s	$\sqrt{\lambda}$
Velocities	1 m/s	6.324 m/s	$\sqrt{\lambda}$
Accelerations	1 m/s^2	1 m/s^2	1
Angles	1 deg	1 deg	1
Mass	1 kg	65.6 tonnes	$(\rho \cdot \lambda^3) / 1{,}000$
Forces	1 kg	643.536 kN	$(\rho \cdot g \cdot \lambda^3) / 1{,}000$
Moments	1 kgm	25741.44 kNm	$(\rho \cdot g \cdot \lambda^4) / 1{,}000$



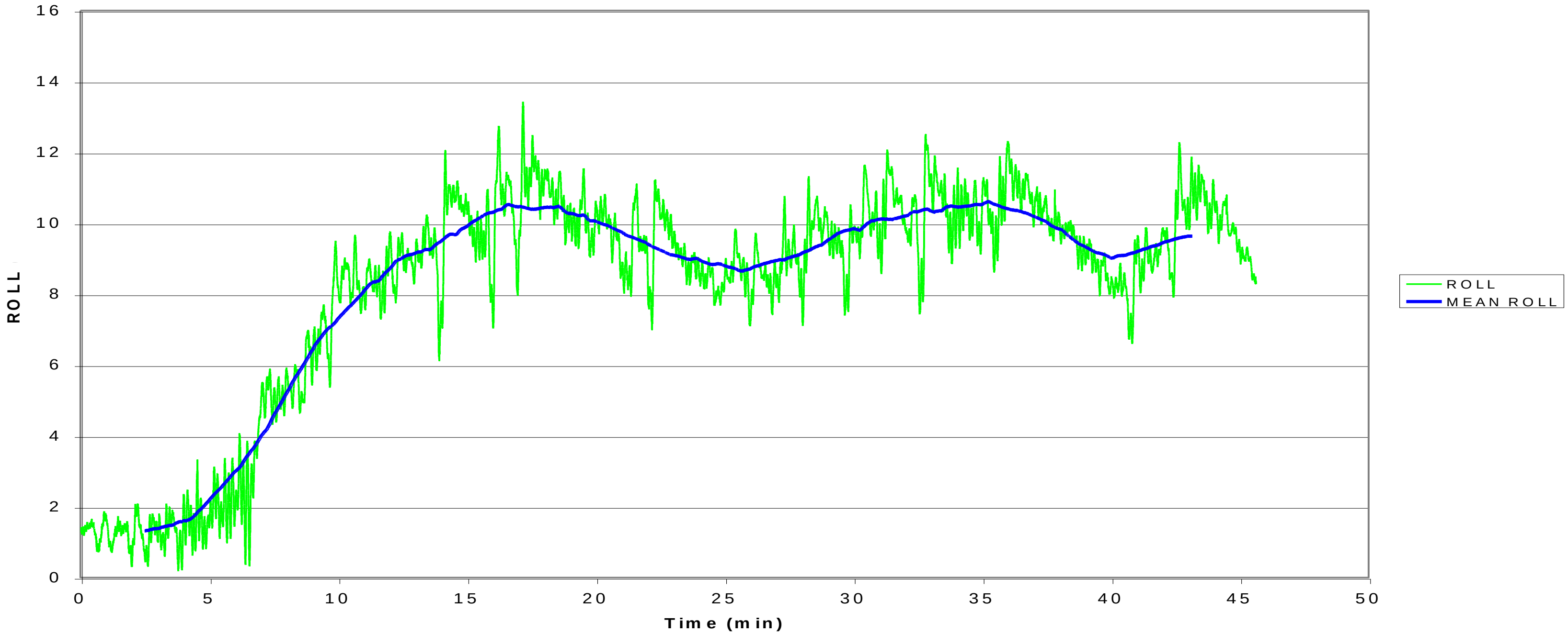




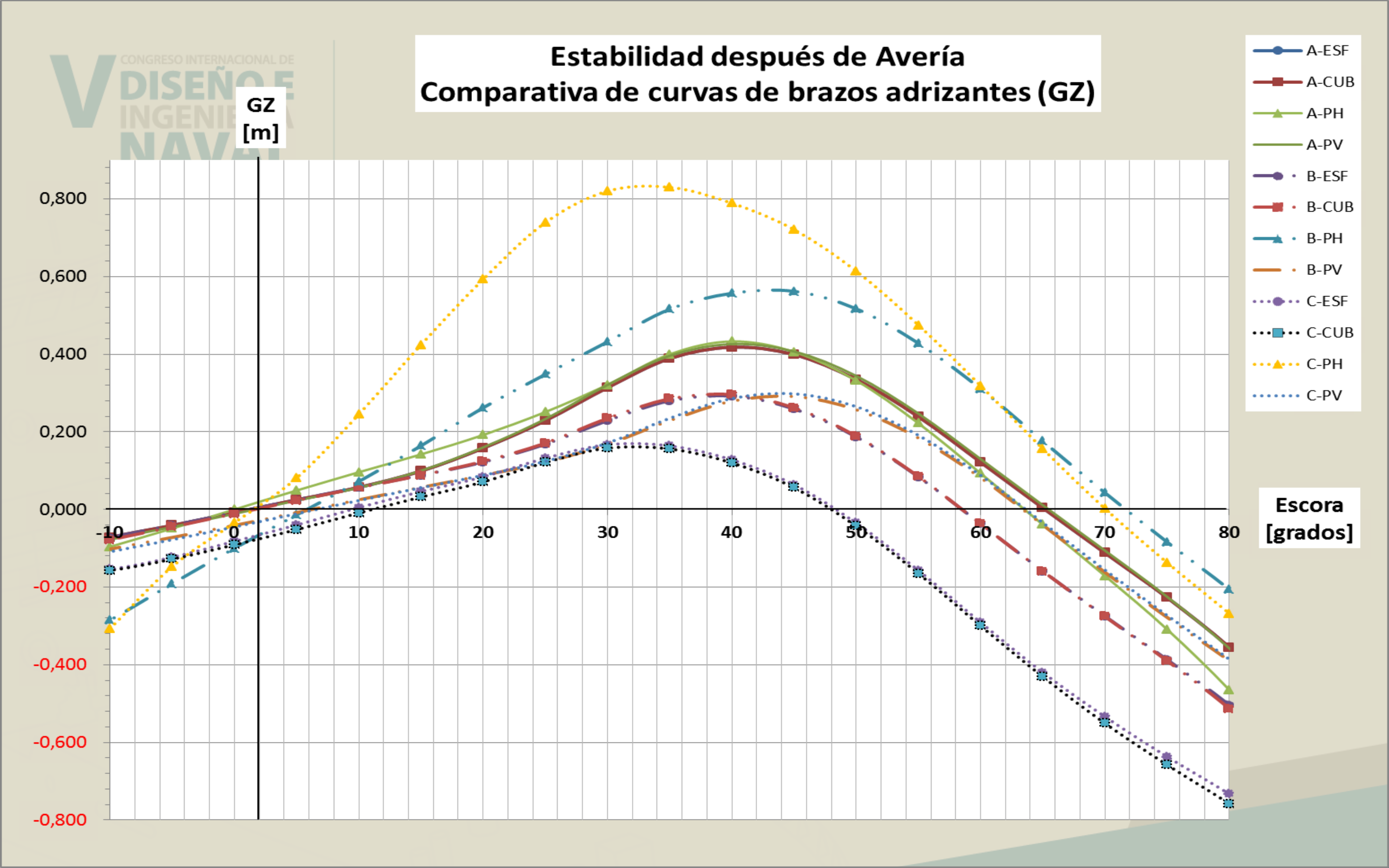
CONGRESO INTERNACIONAL DE
V DISEÑO E INGENIERÍA NAVAL



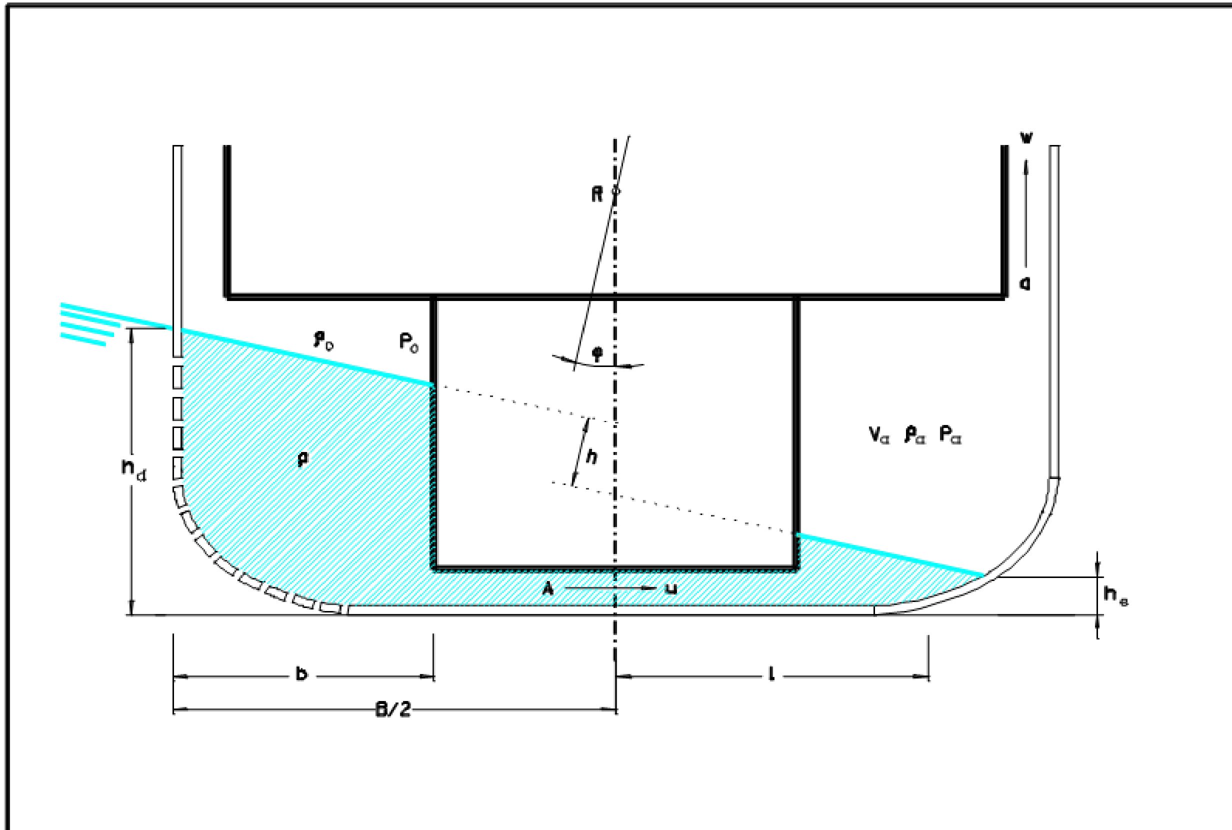
- Lpp > 3 m y λ < 1:40
- Espectro JONSWAP:
    - Tp = 4 $(Hs)^{0,5}$; γ = 3,3
    - Tp = resonancia o bien Tp = 6 $(Hs)^{0,5}$; γ = 1
- 5 carreras x 2 periodos con duración > 30 min
- Si la inclinación es contraria a la avería se repite con 1º escora hacia
- No sobrevive si φ > 30º (> 20% ciclos) o φ > 20º permanente



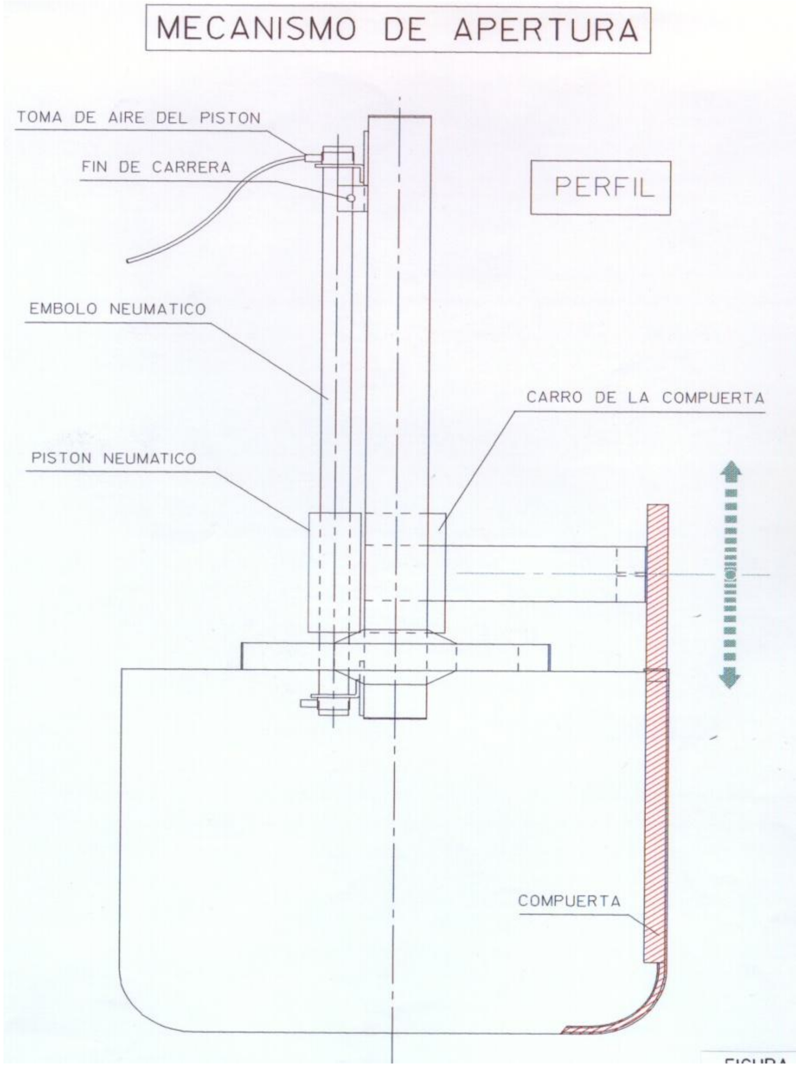
ROLL
Time (min)
ROLL
MEAN ROLL
0
2
4
6
8
10
12
14
16
0
5
10
15
20
25
30
35
40
45
50



Estabilidad después de Avería
Comparativa de curvas de brazos adrizantes (GZ)
GZ [m]
Escora [grados]
0,800
0,600
0,400
0,200
0,000
-0,200
-0,400
-0,600
-0,800
-10
0
10
20
30
40
50
60
70
80
A-ESF
A-CUB
A-PH
A-PV
B-ESF
B-CUB
B-PH
B-PV
C-ESF
C-CUB
C-PH
C-PV

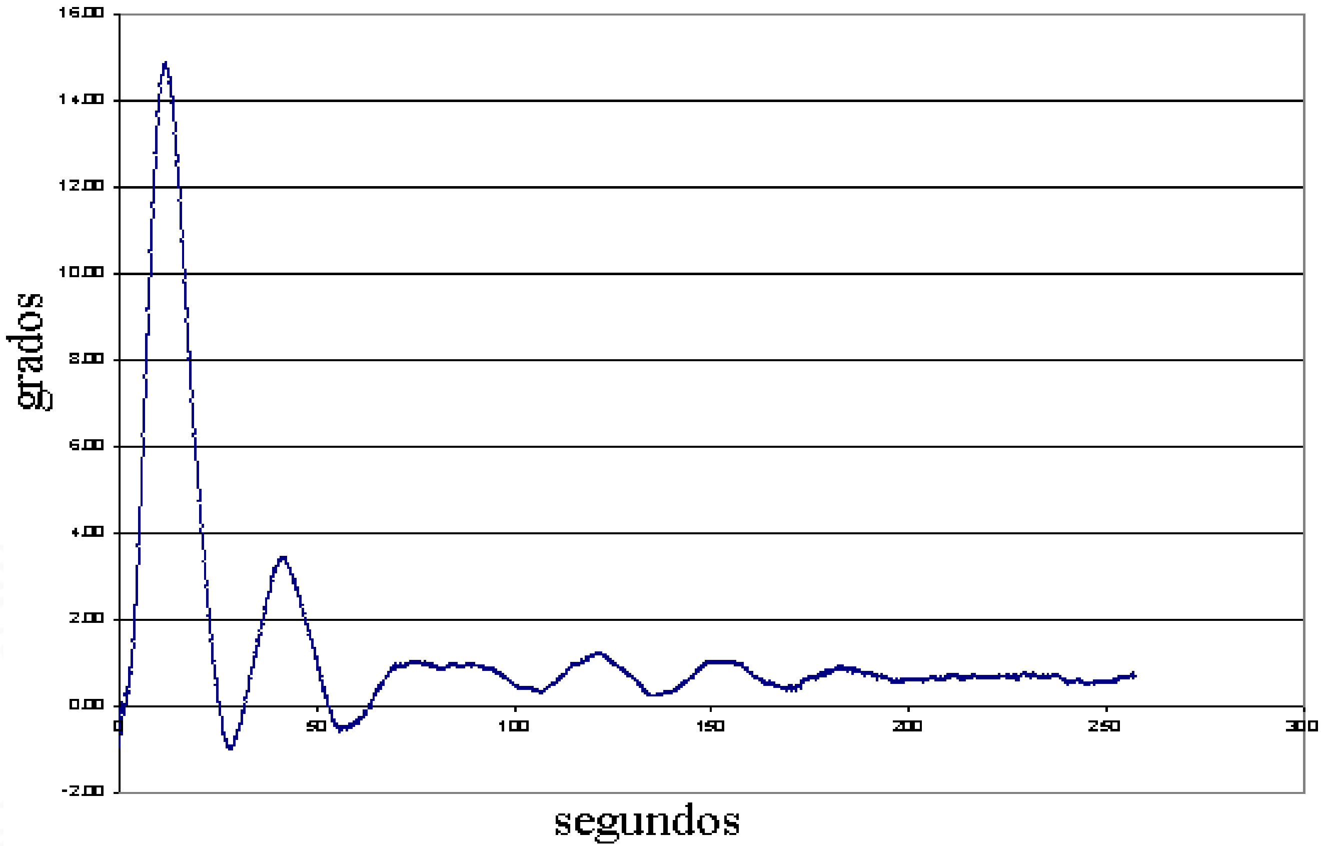

R
w
a
ρo
Po
φ
h
ρ
hd
Va ρa Pa
A
u
he
b
l
B/2

Mecanismo neumático de apertura de avería

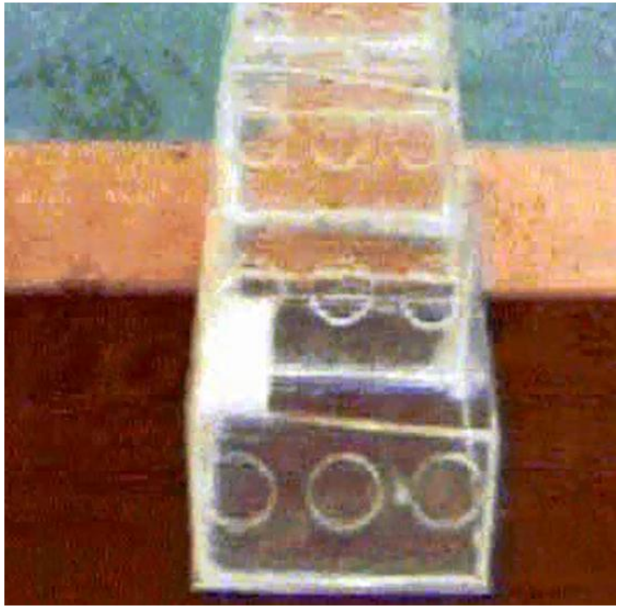


TRANSIENT FLOODING TEST

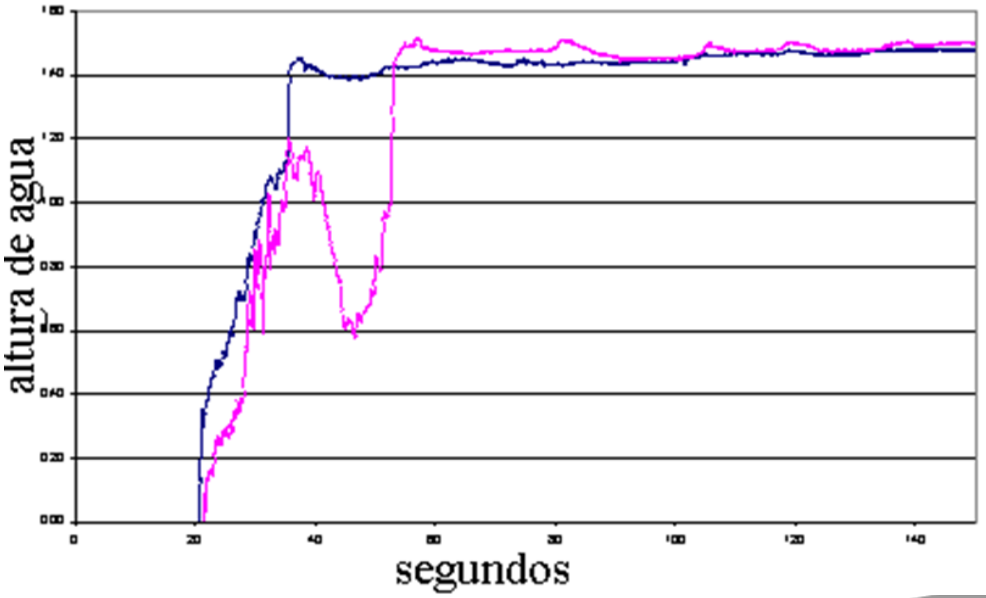
EL PARDO MODEL BASIN



$$\sum_{j=1}^{h}\left\{(M_{i,j}+A_{i,j})\ddot{x}_j(t)+\int_0^{\infty} B_{i,j}(\tau)x_j(t-\tau)\,d\tau + C_{i,j}x_j(t)\right\} = X_i(t)$$



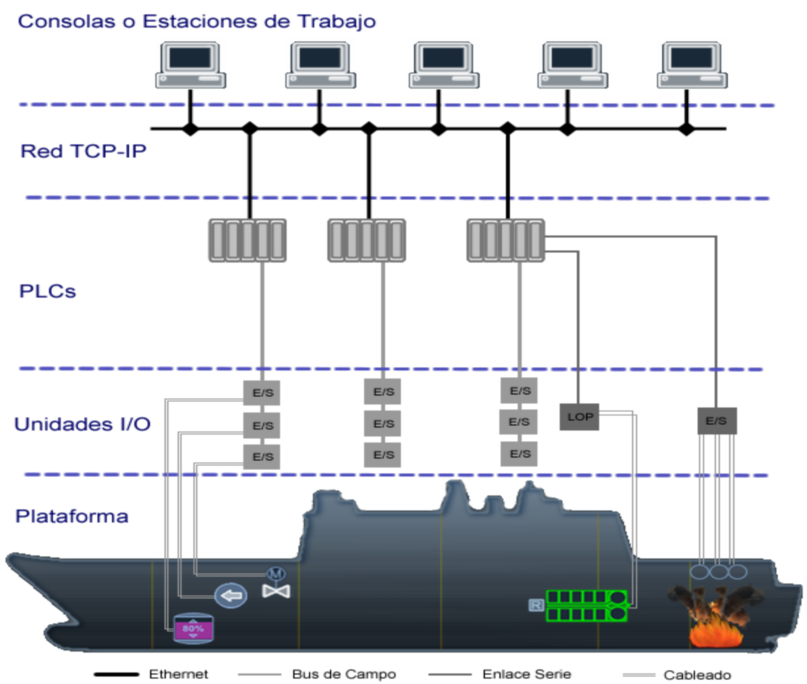
D1 < D2

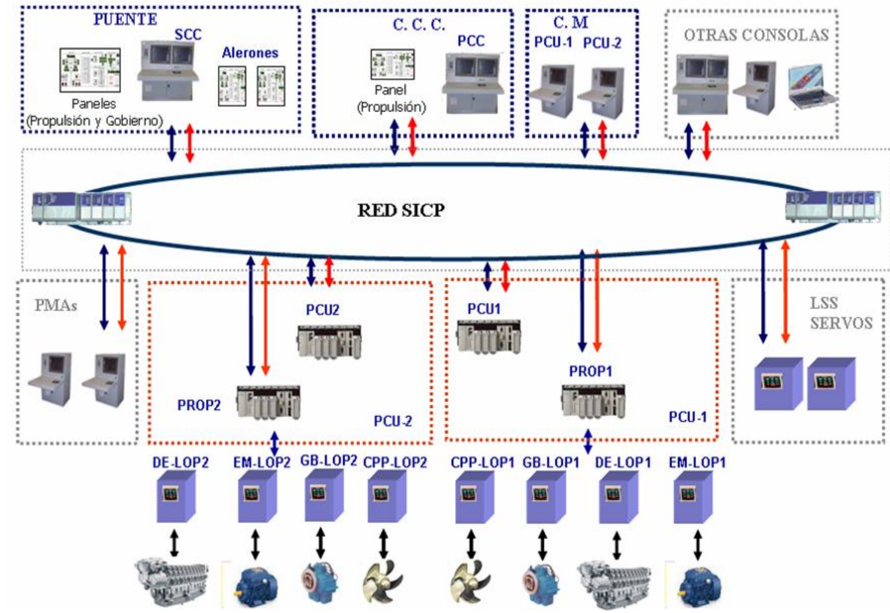


Maqueta digital

Buque real

Sistema Integrado de Control de Plataforma





- El caso menos crítico, categoría A, las zonas afectadas apenas difieren, siendo más favorable para varada.
- En la B, explosión e incendio son similares pero colisión y varada provocan mayor asimetría.
- En la categoría C, la situación más favorable es la varada, seguida de colisión y por último explosión y fuego con un equilibrio asimétrico >10º. La línea margen en popa es el valor más crítico.

- La ANEP-77 explica **cómo** la supervivencia se analiza definiendo **escenarios operacionales**. La seguridad no es sólo de cuestión de regulaciones, necesita capacidad y conciencia de riesgo.

- La serie de Fragatas F-110 destaca por su alto nivel de investigaciones e innovaciones puestas en marcha. De los estudios hidrodinámicos, en especial los de sus efectos dinámicos, los de estabilidad después de avería proporcionan datos vitales para alimentar el **SICP** y la maqueta virtual (industria 4.0)

V CONGRESO INTERNACIONAL DE DISEÑO E INGENIERÍA NAVAL

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