

# Submarine Damage Control System

## Spanish Navy Experience

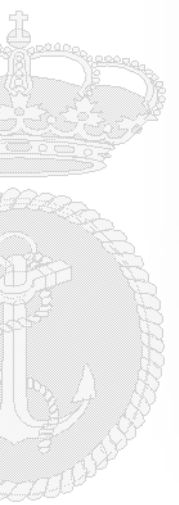


**Naval Damage Control (NDC)**  
**Conference**  
**Farnborough, UK**  
**24 May 2023**

**LCDR Francisco SOLANO, Spanish**  
**Navy**



# Spanish Navy Submarine Base





# Submarines that I have served on



S-60 Class (Daphne-type)



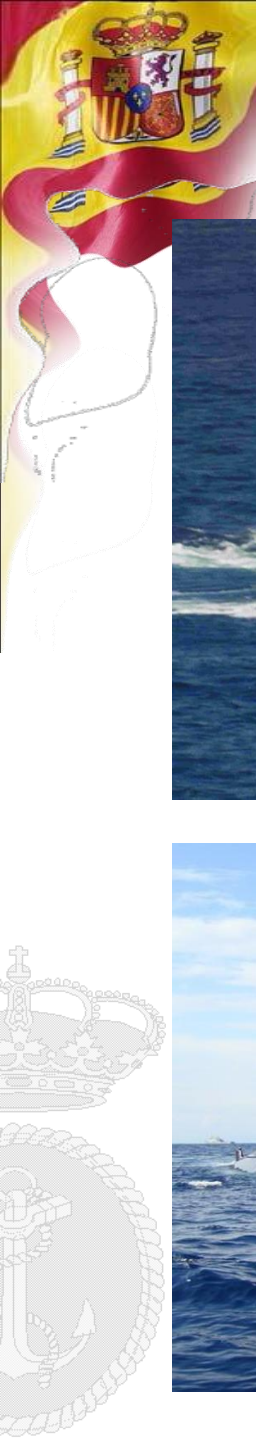
Scorpene Class (Malaysia)



S-70 Class (Agosta-type)



S-80 Class



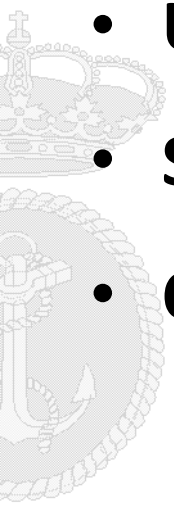


# Submarine Damage Control System

## Spanish Navy Experience

### AGENDA

- Spanish Navy submarine history & platform control systems evolution
- S-80 Submarine Platform Control System =  
Integrated Platform Management System (IPMS) + Non-Integrated Control System
- Use of “Kill-Cards” in IPMS to improve Damage Control System capabilities
- Submarine damage control training, computer-based & mock-up simulators
- Conclusions and recommendations for future platform control systems





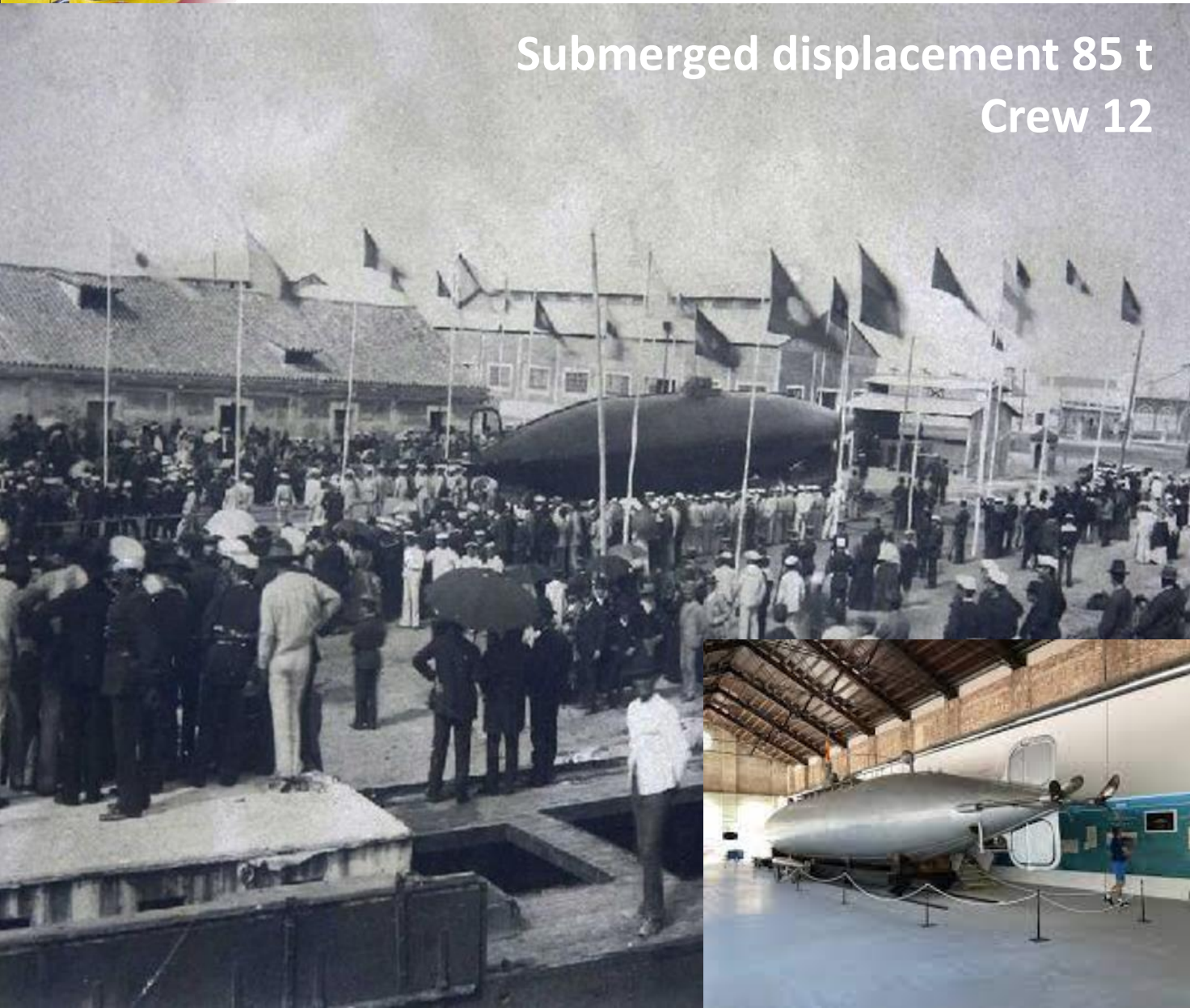


# It all started with Isaac Peral

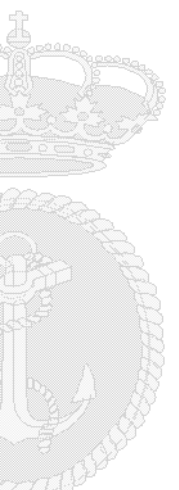
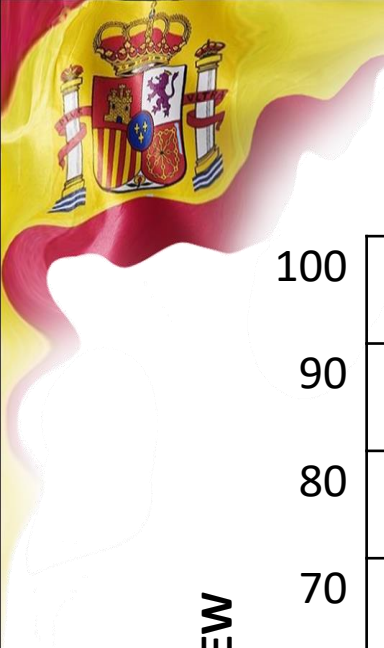
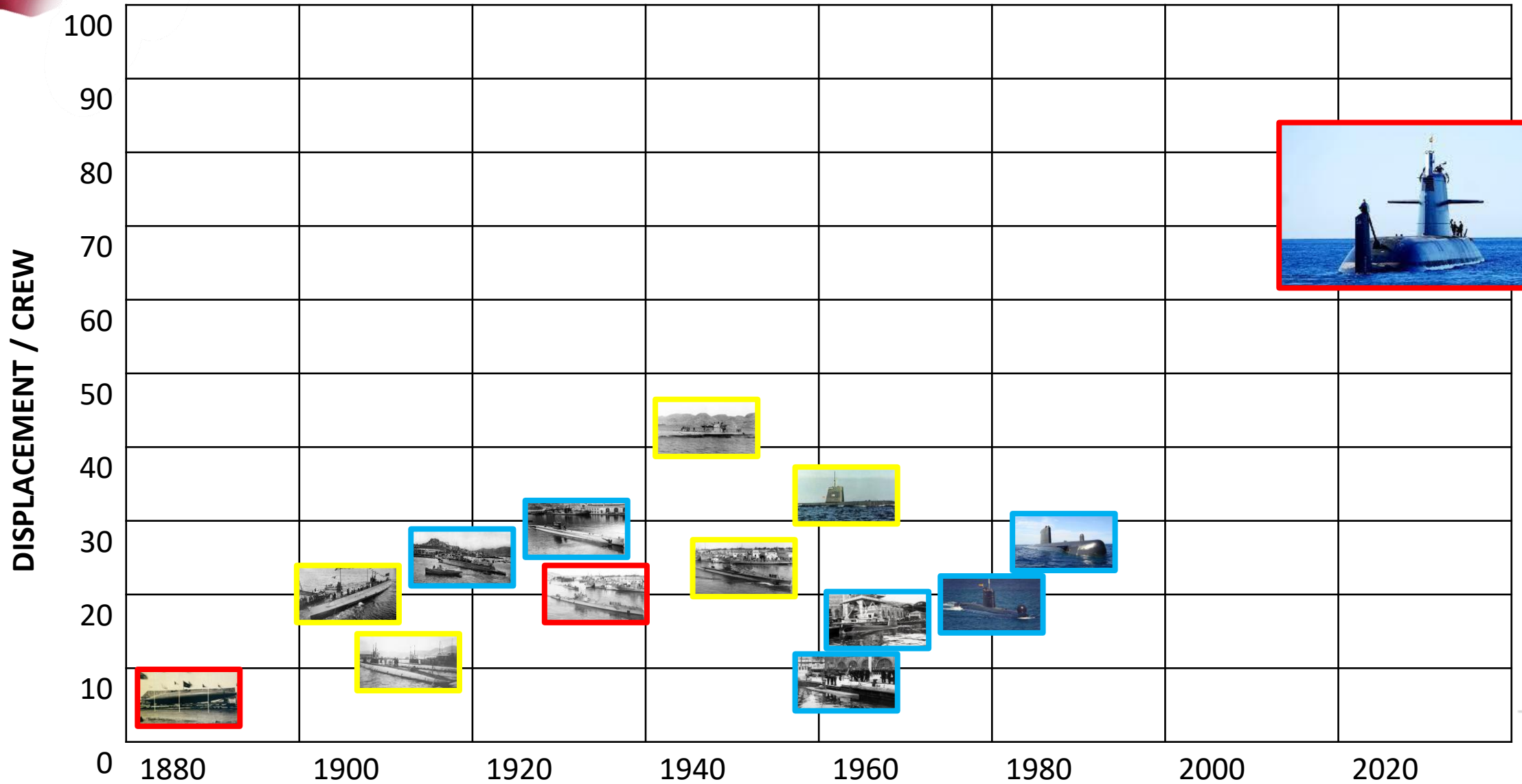


Submerged displacement 85 t  
Crew 12

It was the world's first successful full electric battery-powered submarine, designed and built in Spain by Lieutenant **Isaac Peral** in **1888**.



# Spanish Navy Submarine History





# Guppy Class



**S Class (Guppy-type)**  
**Designed and built in USA in 1943**  
**Submerged displacement 2460 t**  
**Crew 80**





# S-60 Daphne Class



**S60 Class (Daphne-type)**  
**Designed in France and built in Spain in 1973**  
**Submerged displacement 1043 t**  
**Crew 56**





# S-70 Agosta Class

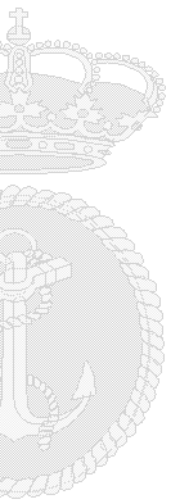


**S70 Class (Agosta-type)**

**Designed in France and built in Spain in 1983**

**Submerged displacement 1490 t**

**Crew 60**

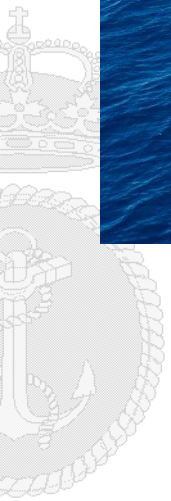




# S-80 Isaac Peral Class



**S-80 Isaac Peral Class**  
**Designed and built in Spain 2023**  
**Submerged displacement 3000 t**  
**Crew 40**





# S-80 Isaac Peral Class



# Damage Control Lessons Learnt

1. **DETECTION IS ESSENTIAL.**
2. **LOCATION WHERE THE INCIDENT IS HAPPENING**
3. **FIRST REACTIONS ARE VITAL TO AVOID THE FIRE-SMOKE SPREAD**
4. **ELECTRICAL AND MECHANICAL ISOLATION OF COMPARTMENT**
5. **RELIABLE BREATHING EQUIPMENT AND COMMUNICATIONS ARE VITAL**
6. **TRAINING IS CRITICAL.**







# Platform Control System Requirements

## Use of Spanish Navy IPMS

**1st Generation**  
(Centralized integrated control)



Oceanographic



Hydrographic



Patrol Vessel



AOR



Corvette



Frigate

**2 Generation**  
(Distributed integrated control)



AOR



LPD



Aircraft Carrier



Frigate



Minehunter



**3rd Generation**  
(Information System)



LHD



AOR



Patrol Vessel



Frigate



Submarine



Frigate



Submarine Rescue



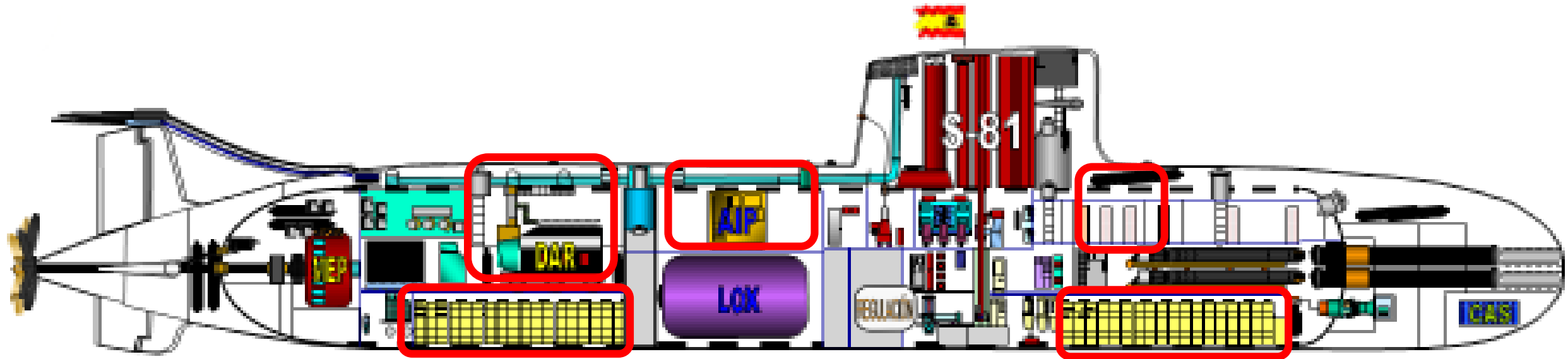
Hydrographic



Oceanographic



# Platform Control System Requirements

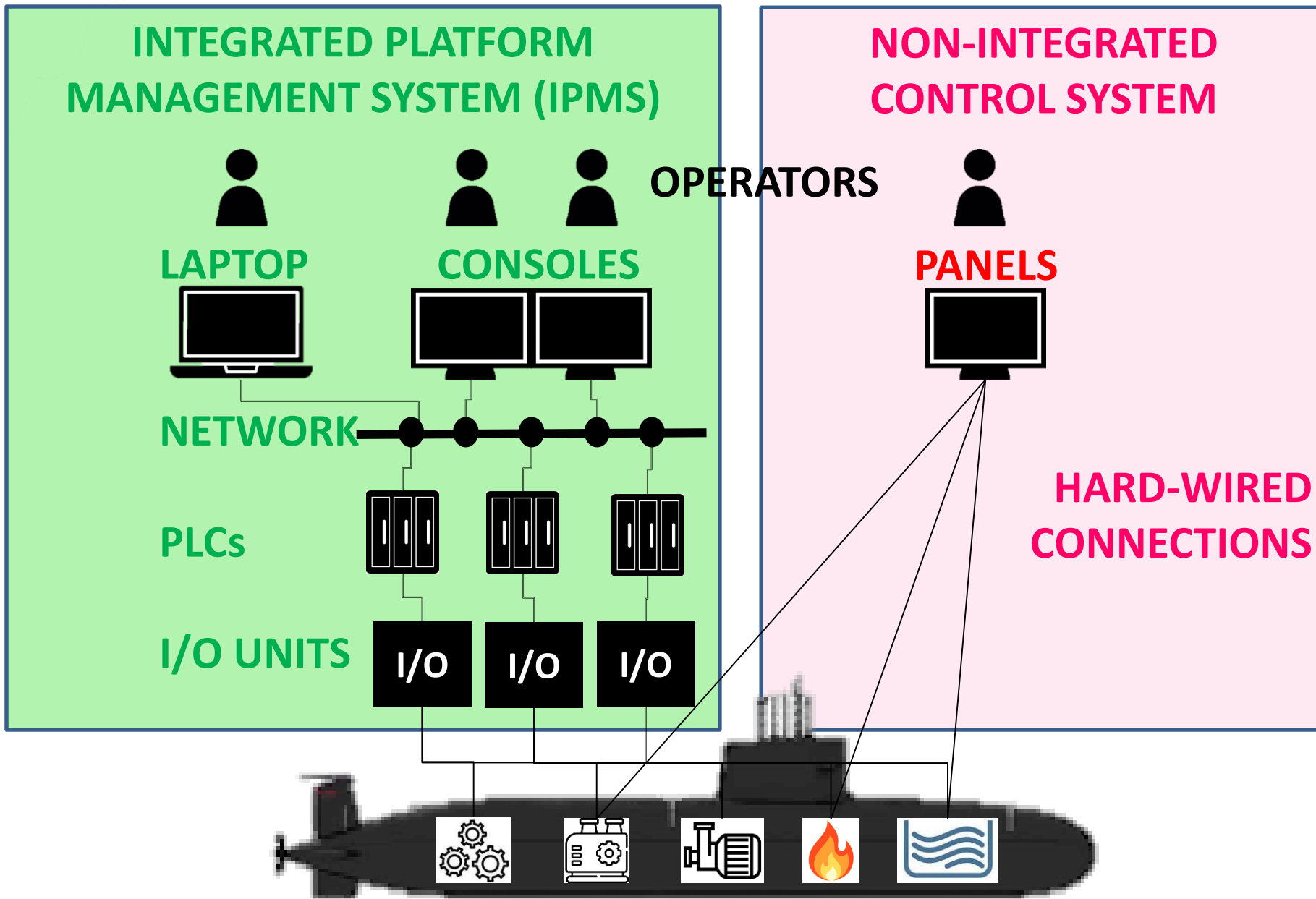


- REDUNDANT AND STRONG ARCHITECTURE IN ALL SYSTEMS
- SPECIAL DESIGN IN FIRE RISK COMPARTMENTS (Batteries, Diesel, AIP, Galley)
- DIFFERENT CONTROL MODES: REMOTE (IPMS) AND LOCAL
- **NON-INTEGRATED PANELS** TO EMERGENCY REACTIONS
- REDUCED NUMBER OF CREWMEMBERS





# Platform Control System Architecture



# Platform Control System HMI



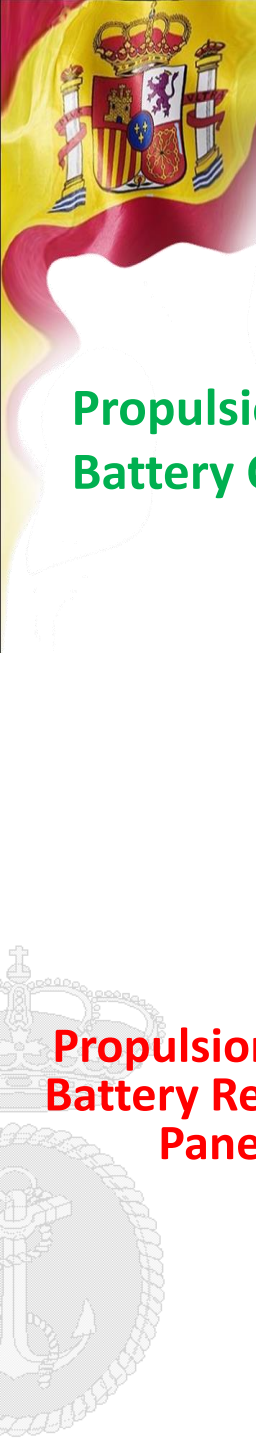
Diving Safety Reserve Panel

Propulsion and Battery Console

Diving Safety Console

Propulsion and Battery Reserve Panel

Platform Control System = IPMS (Integrated Consoles) + Non-Integrated (Panels)





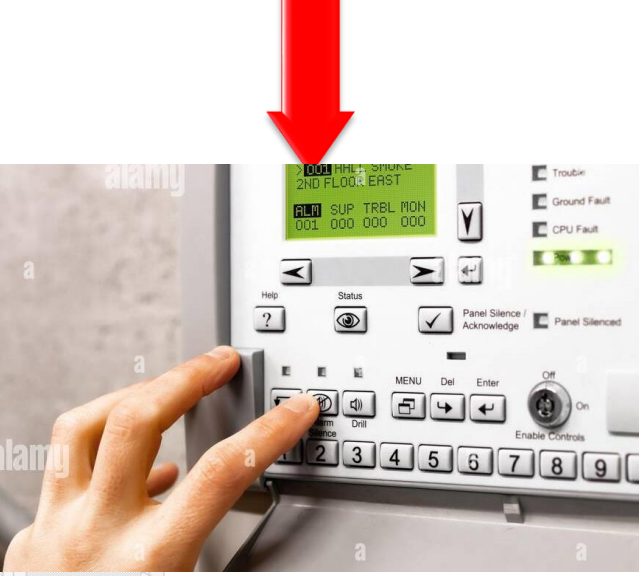
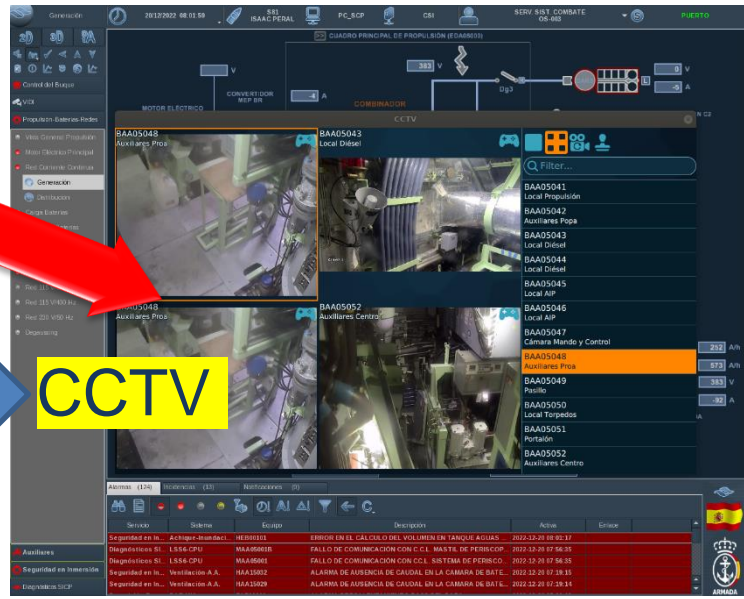
# Firefighting System

- **FIXED INSTALLATION OF SPRAYED WATER TO DIESEL AND AIP COMPARTMENT.**
- **FIXED INSTALLATION OF CO<sub>2</sub> TO BATTERIES, MAIN SWITCHBOARDS AND GALLEY WITH BACKUP BOTTLE.**
- **REDUNDANCY DETECTION IN ALL COMPARTMENTS.**
- **FROM NON-INTEGRATED PANELS STOP VENTILATION, ISOLATION AND TRIGGER FIXED INSTALLATIONS.**
- **CLOSED CIRCUIT OF TELEVISION (CCTV).**



# Kill Cards

1. ACTIVATION OF FIRE DETECTOR.
2. ALARM IN FIRE CENTRAL PANEL.
3. ALARM IN IPMS AND NON-INTEGRATED PANELS, CCTV SHOW IMAGE OF COMPARTMENT AND APPEARS KILL-CARD.





# Kill Cards

VistaGeneral 30/01/2023 13:36:26 CSI CSI COMANDANTE 0-1 SNORKEL

PLANTA PROPULSORA Y PLANTA ELÉCTRICA (CC) NAVEGACIÓN

357 V 206 A COMBINADOR BATERIA DE PROA 357 V -388 A 69 % Db2 TEMPERATURA 27.0 °C

TRRD-01 (PROPULSIÓN)

| KillCards | Compartimento | Origen | Reacciones Inmediatas Generales | Reacciones Inmediatas Particulares | Reacciones Diferidas     |
|-----------|---------------|--------|---------------------------------|------------------------------------|--------------------------|
| TRRD-01   | 2-28-0-E      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-02   | 1-36-0-E      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-03   | 2-36-0-E      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-04   | 3-33-0-E      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-05   | 3-47A-0-Q     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-06   | 2-48-0-E      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-07   | 3-63-0-Q      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-08   | 1-63B-0-E     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-09   | 3-631-0-E     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-10   | 1-78-0-C      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-11   | 1-82A-2-Q     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-12   | 3-82B-0-E     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-13   | 2-82D-2-Q     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-14   | 3-99-0-Q      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-15   | 1-99-0-L      |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |
| TRRD-16   | 2-103-0-M     |        | <input type="checkbox"/>        | <input type="checkbox"/>           | <input type="checkbox"/> |

| Elemento                              | Inhib./Est.Act.          | Orden/Est.Des. | Control | Descripción                            |
|---------------------------------------|--------------------------|----------------|---------|--|
| - Detectores de Incendio (Prealarmas) |                          |                |         |  |
| JBA15113                              | <input type="checkbox"/> |                |         | DETECTOR HUMO PROPULSIÓN 01            |
| JBA15212                              | <input type="checkbox"/> |                |         | DETECTOR HUMO PROPULSIÓN 02            |
| - Detectores de Incendio (Alarmas)    |                          |                |         |  |
| JBA15113                              | <input type="checkbox"/> |                |         | DETECTOR HUMO PROPULSIÓN 01            |
| JBA15212                              | <input type="checkbox"/> |                |         | DETECTOR HUMO PROPULSIÓN 02            |
| - Incidencias                         |                          |                |         |  |
| Incendio                              | <input type="checkbox"/> |                |         | INCIDENCIA SEGURIDAD INTERIOR DOTACIÓN |

VIDI Propulsión-Baterías-Rede Auxiliares Seguridad en Inmersión Diagnósticos SICP

Fecha/Hora Tipo Estado Compartimento Comentarios Activar Windows Ve a Configuración para activar Windows

PROA 5 ° L 0 L 00 L 10 L 50 bar 8.0 bar 8.0 bar 8.0 bar RIOR 5.0 bar 5.0 bar 5.0 bar



# Integrated Project Team

Design  
Engineer

Submariners  
(operators)

Safety  
Engineer

Electrical  
specialist

Software  
Engineer

Mechanical  
specialist

Systems  
Engineer

Doctrine  
(Damage  
Control)



Designer

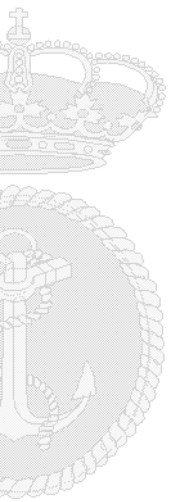
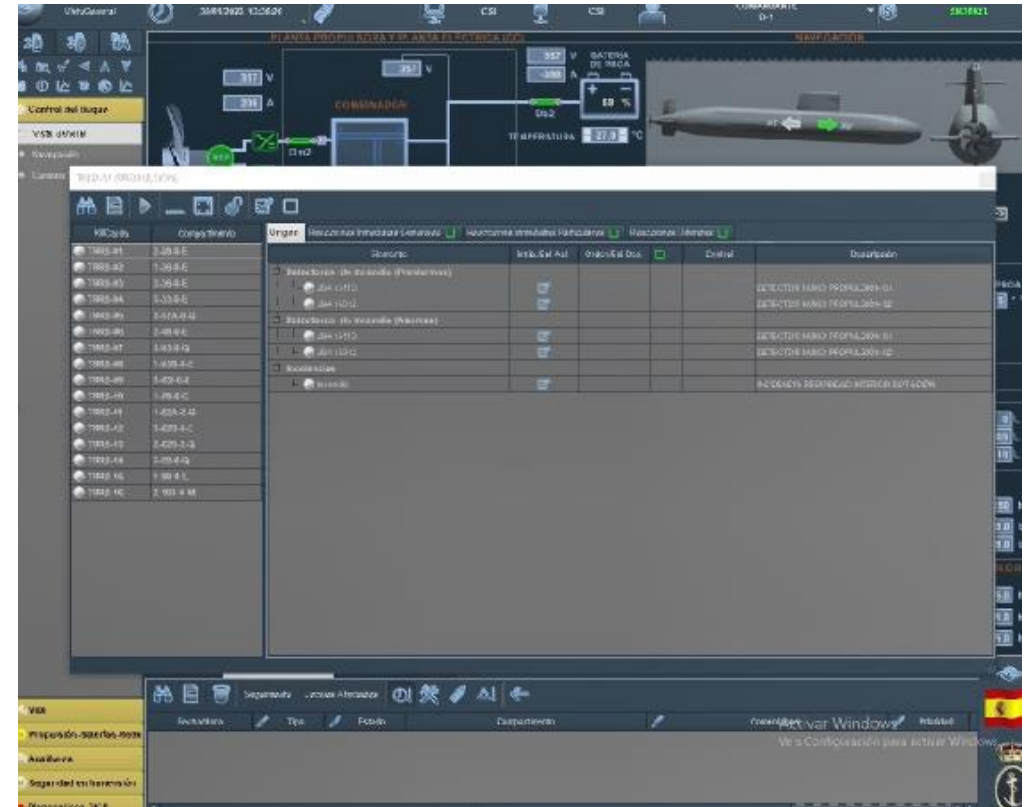
User





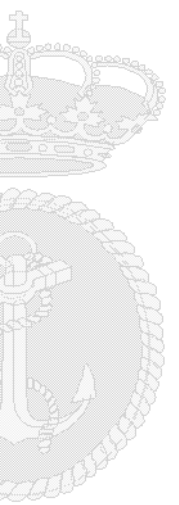
# Advantages of Kill Cards

- ✓ Reduced human error
- ✓ Reduced incident response time
- ✓ Increased reliability
- ✓ Increased robustness



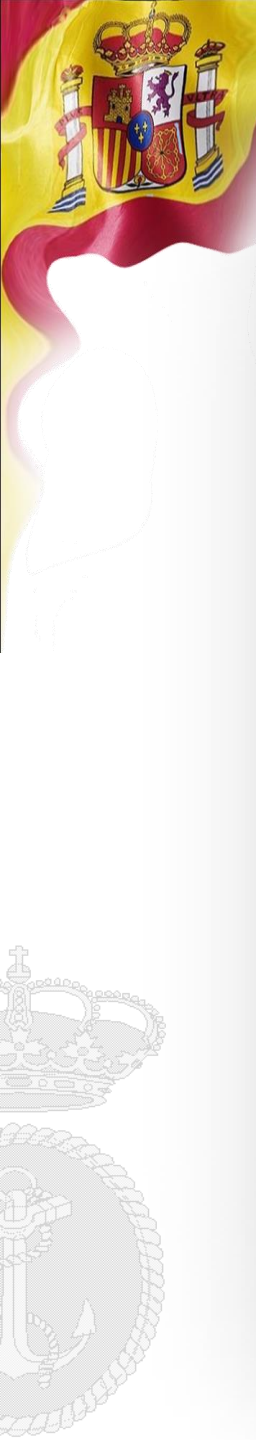
# Training Process

- **Basic Navy training**
- **Submarine theoretical training phase**
  - General submarine knowledge
  - Specific training in accordance with role
- **Submarine simulators**
  - Computer Based Training (CBT) for platform control system console operators
  - SIMulator of the PLAtform (SIMPLA) with movement for complete duty watch
- **Onboard training for all submarine crew members**





# Antonio de Escaño Training School





# S-80 NAVANTIS (Training Integrated System)

## NAVANTIS AIT

(Virtual Reality Avatar Immersion Tool)

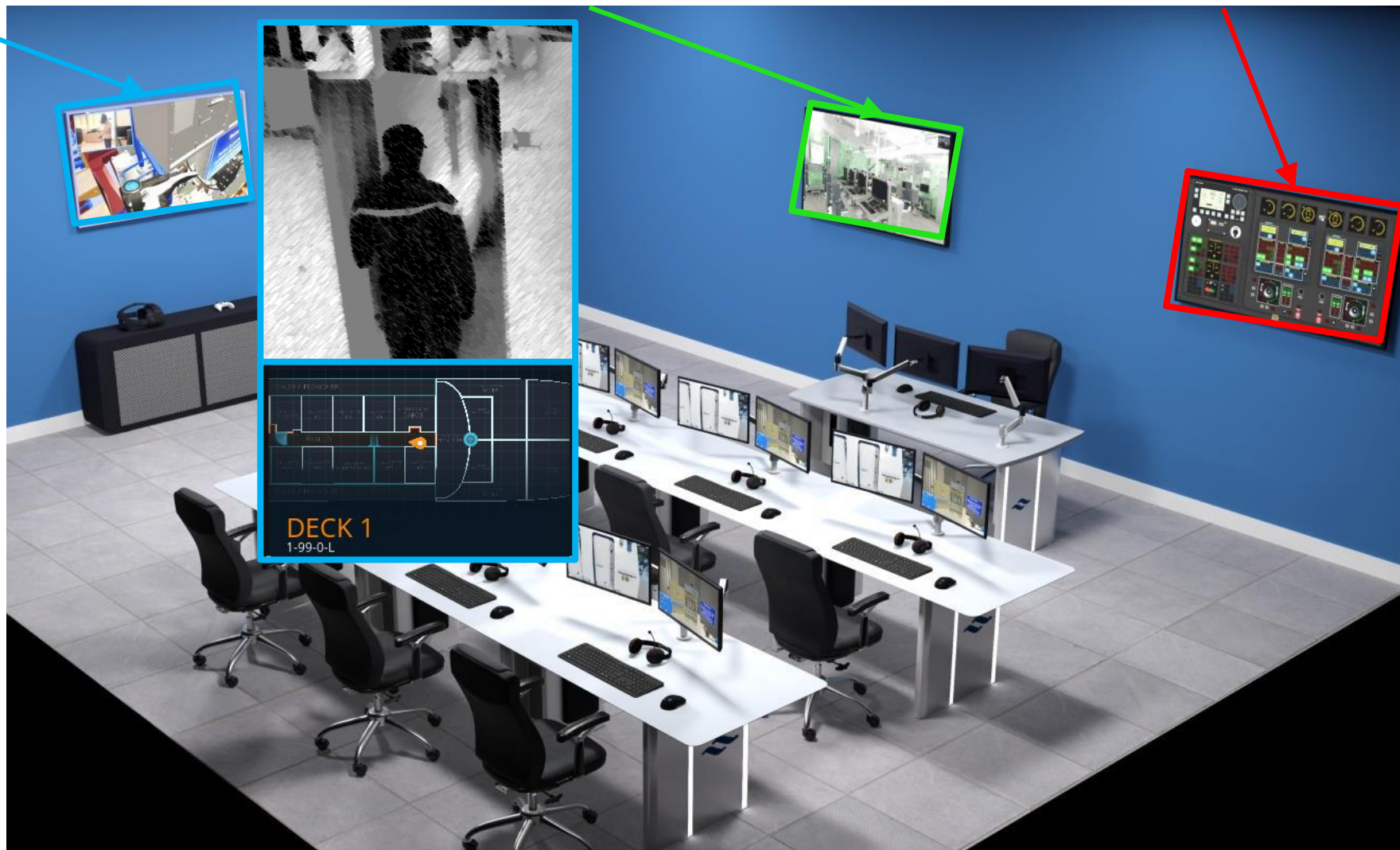
## NAVANTIS NMTC

(Maintenance Training Content)

## NAVANTIS PLATFORM

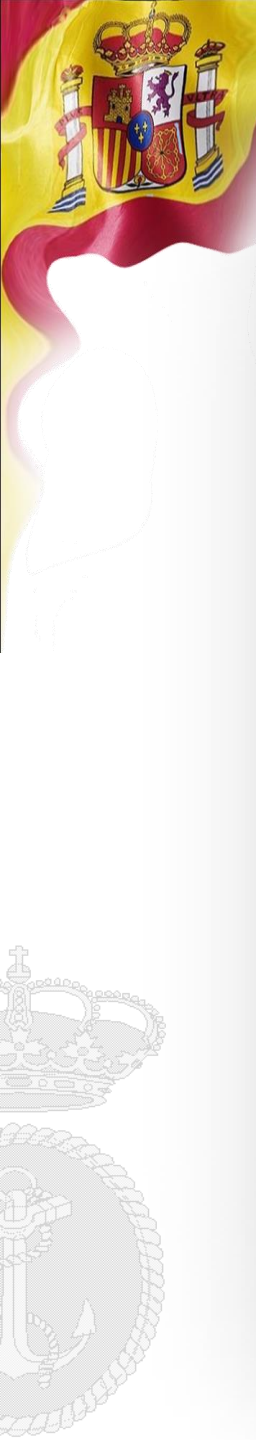
(IPMS, SNIC, Local Control Panels)

- Fully integrated training modules
- Individual training
- Collective training
- Scenarios using submarine 3D model and real equipment and systems data

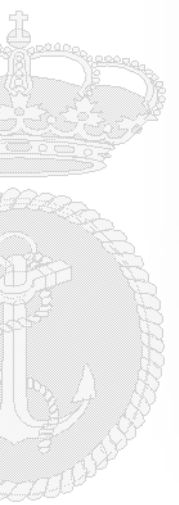




# S-80 Computer Based Trainer (CBT)

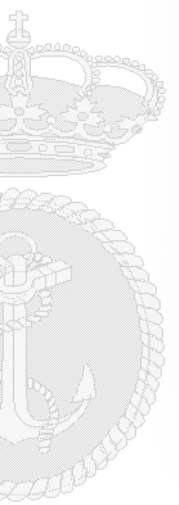


# S-80 Simulator Platform (SIMPLA)



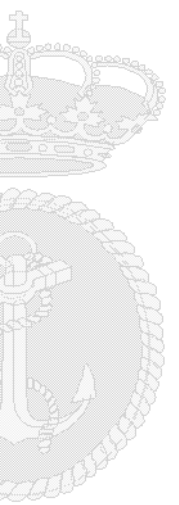


# Onboard Training Drills



# Conclusions

- ✓ Reduced detection time
- ✓ Reduced incident response time
- ✓ Reduced individual and collective/duty watch training times
- ✓ More complete training
- ✓ Better use of time on board for training
- ✓ Higher quality training and analysis by instructors





# Future Damage Control Systems

- Include IR cameras in CCTV
- IPMS on wireless hand-held devices, easy access to information
- An exclusive console for Damage Control
- ? Integrate artificial intelligence into IPMS



# Submarine Damage Control System

## Spanish Navy Experience

Thanks for your attention.

Any questions?



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