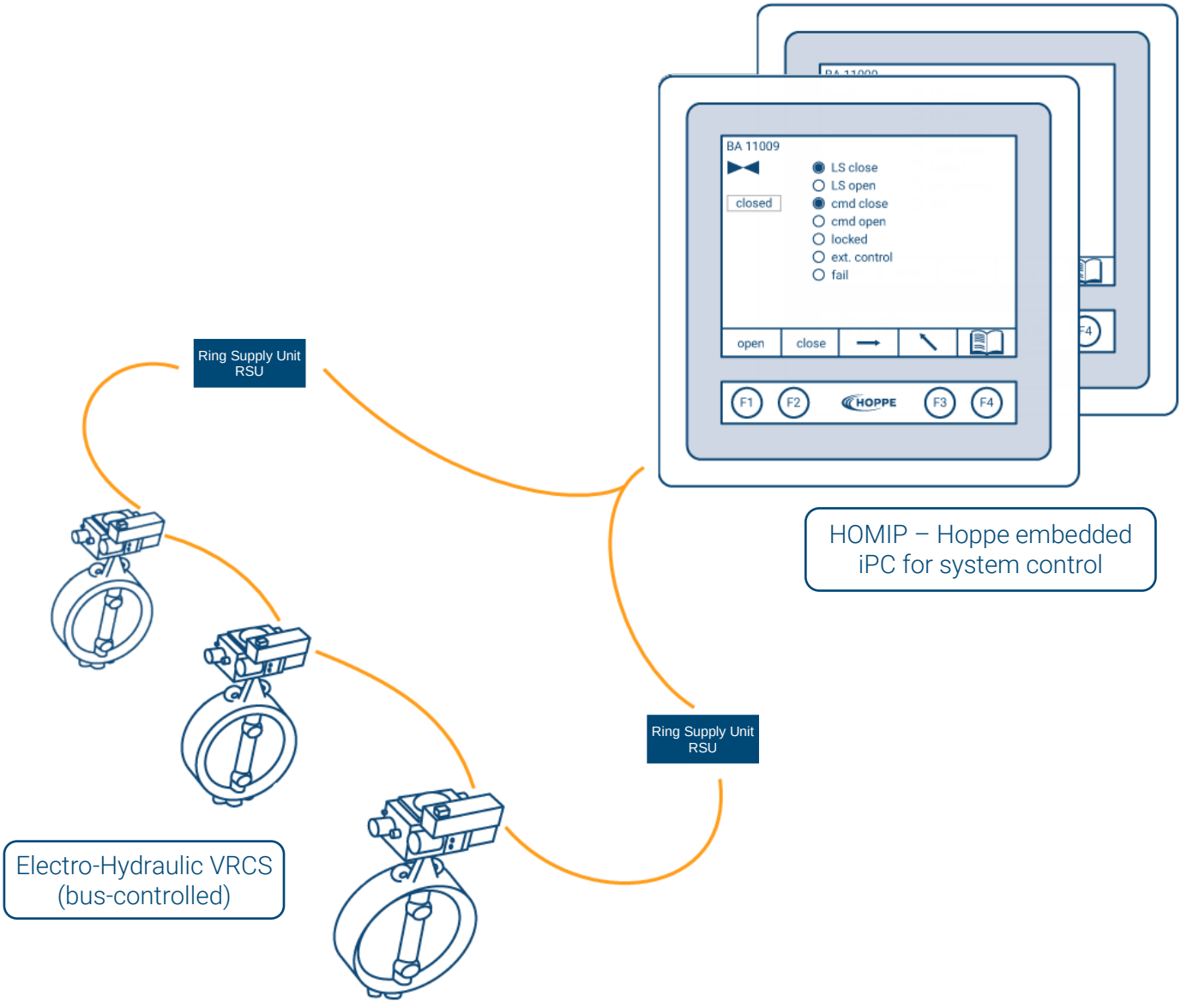
System Design Concept
for Safe Return to Port (SRtP) regulations

Hoppe Valve Remote Control System (VRCS)
with bus-controlled valves type HOBUS-V



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1 General

Increasing the vessels robustness, fault tolerance and its ability to safely return unsupported back to port – that are the most important intentions behind the technical concepts for the so called “Safe Return to Port (SRtP)” regulations.

Generally stated by SOLAS II-1/Reg. 8-1, SOLAS II-2/Reg. 21 and SOLAS II-2/Reg. 22, the primary objective of the SRtP regulations is to meet the principle that “**a ship is its own best lifeboat**” and to ensure that the required systems are designed and arranged under the aspects of adequate redundancy and segregation. Thus, any fire or flooding casualty will only have very limited effects and the required systems are capable of being restored and remain operational until a safe port can be reached under the vessels own power. During the SRtP voyage, all persons onboard shall be accommodated in safe areas where health and safety services are available.

Therefore, the SRtP regulations defines certain systems as being “**essential systems**” to be available in order to ensure propulsion, manoeuvrability and to maintain safety in such areas onboard that are not affected by a flooding or fire casualty.

The Safe Return to Port (SRtP) regulations require a **multi-disciplinary work approach** and each stakeholder shall observe the functional requirements of the various systems which are supposed to remain operational in a threshold after a casualty.

With the design of our **HOPPE bus-controlled valve control system HOBUS-V**, we comply with the requirements of the SRtP regulations under the aspects of system security, system availability and system recoverability after a casualty.

1.1 System design philosophy

The remotely operated HOPPE bus-controlled valve control system is designed in a ring topology, exclusively for remote controlled valves. The advantages of a ring topology, where the source signal circulates in a loop until the intended valve-actuator combination has been detected, are of high reliability and reduced cabling and installation effort.

This solution is especially useful in the event of a malfunction, due to the fact, that no components from other systems are integrated in this concept. Hence, a problem with the remote bus-controlled valve control system does not affect e.g. level monitoring sensors for tanks or draft. In this way, the independence of the systems is guaranteed in the event of a fault.

1.2 Cabinet design and location

The remotely operated HOPPE bus-controlled valve control system consists of a minimum of two valve control cabinets which are located in safe compartments above the waterline. The design relates to the SOLAS II-2/Reg. 3 definitions for "**Main Vertical Zones (MVZ)**", whereas these are "*those sections into which the hull, superstructure, and deckhouses are divided by "A" class divisions, the mean length and width of which on any deck does not in general exceed 40m*".

The first valve remote control cabinet is located in the aft main vertical zone of the vessel. The second valve remote control cabinet is located in the forward main vertical zone of the vessel. If there are more than two main vertical zones, more valve remote control cabinets are arranged, so that there is a valve remote control cabinet in each main vertical zone.

1.3 Control philosophy

Each valve remote control cabinet is equipped with a HOMIP (**HOPPE embedded iPC for system control**). The HOMIP is a LINUX-based embedded iPC, acting as a controller and interface to the vessels IAMCS. If the interface to the IAMCS fails, the HOMIP acts as an emergency controller to operate the valves and keep the remote control valve system operational.

The application software installed on the HOMIP is protected against any manipulation by third parties. Changes to the software are only possible by qualified personnel. Parameter settings and update routines are password protected.

Application software as well as system parameter settings are stored in a safe databases. If the system needs to be restored, the small size of the application software and the parameter files means that they can also be sent via vessels e-mail.

1.4 Redundancy of power feeding for VRCS cabinets

The HOBUS-V VRCS contains a 3~230Vac power feeding from the Main Switch Board (MSB) and the Emergency Switch Board (ESB) including switch over from MSB to ESB. The status of which power feeding is active is shown by LEDs in the front door of each VRCS cabinet.

Note: Two VRCS cabinets via two main vertical zones need synchronous power feeding for both cabinets.

1.5 Valve loop architecture

The HOBUS-V VRCS is designed in a way of a loop architecture. This architecture ensures the system availability in the event of a fault due to a failure of a bus controller or in the event of a cable damage in the loop. An interrupted valve loop will be detected by the system and triggers an "open loop" alarm.

1.6 Ring Supply Units (RSU)

The HOBUS-V VRCS provides operational safety through optimized power and bus management with so called Ring Supply Units (RSU). The RSU serves as a supply terminal and bus head for the **intelligent valve control**. By means of Ring Supply Units (RSU), the valve bus loop will be initialized with reduced current until it is completely initialized.

1.7 Bus-coupler design

The HOBUS-V VRCS bus coupler offers a function to enable on-site control of the valve-actuator combination: Status LEDs provide local indication of the valve's status, and by holding a magnet in front of these LEDs, the valve can be controlled manually on-site. This local control function is the last operational stage before using the portable hand pump for local valve control.

The LEDs indicate the following valve status:

●	Blue: local control via magnet.		Blue (blinking): valve bus loop initialisation.
●	Yellow: Valve is closed.		Yellow (blinking): Valve is closing.
●	Green: Valve is open.		Green (blinking): Valve is opening.
			Red (blinking): Valve failure.

1.8 Actuator design

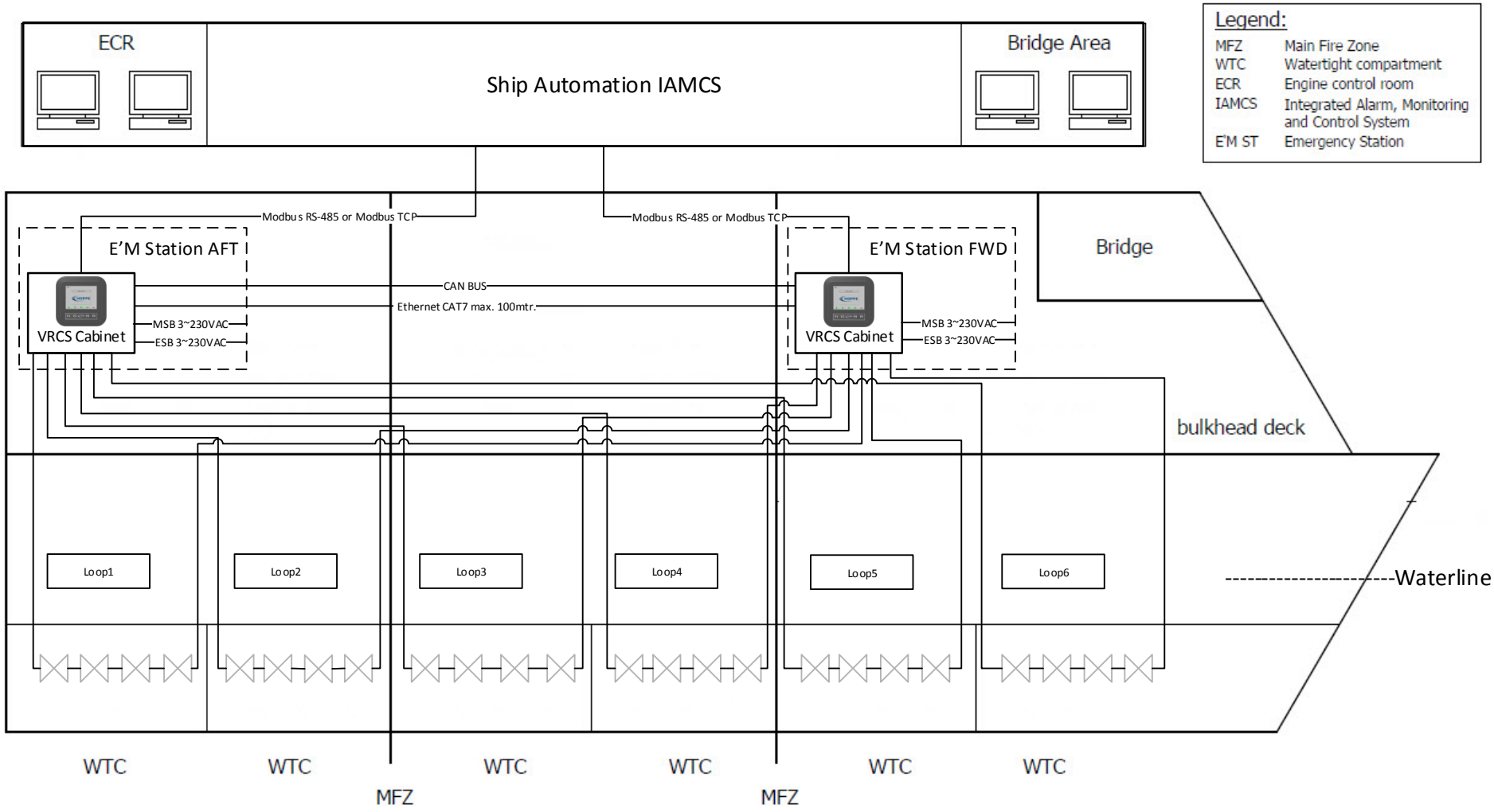
The low-maintenance electrohydraulic actuators are characterized by their **robust and compact design**. The actuators are available as 90°-rotating actuators or as linear actuators. All actuators offer a mechanical position indicator on-site as well as connections for a portable hand pump. The compact design allows the function to be maintained in an event of temporary flooding. The modular actuator design allows swift replacement of components, if necessary. Wall mounted remote control stations are optionally available.

1.9 Feature summary

To summarize all features of our HOBUS-V Valve remote Control system (VRCS) once again:

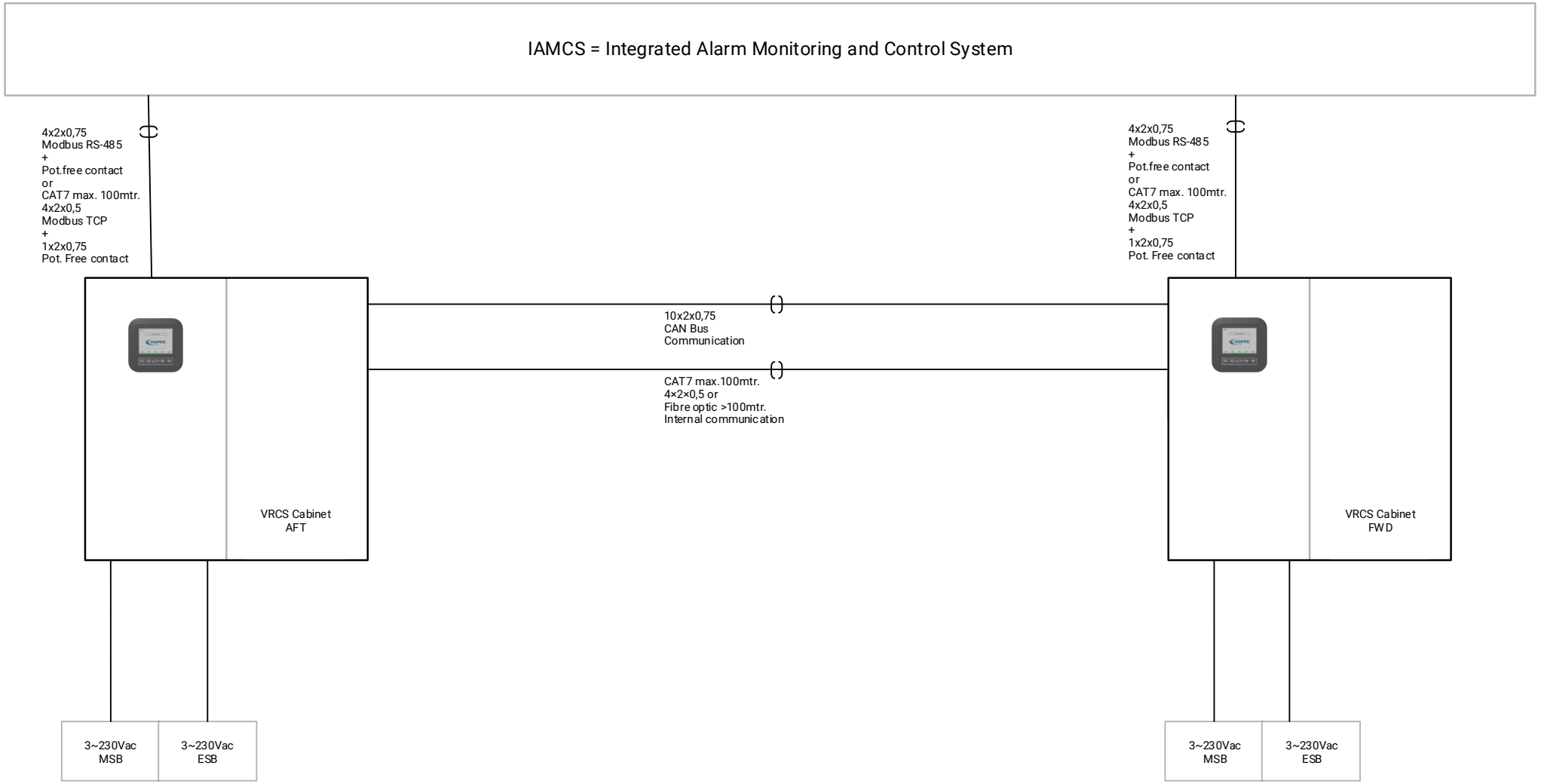
- **VRCS Cabinets** located in safe compartments above the water line.
- **Redundancy of power supply for VRCS cabinets** with power supply from Main Switch Board (MSB) and Emergency Switch Board (ESB), including LED status
- **Redundancy of VRCS control** containing two HOMIP (HOPPE embedded iPC for system control), with HOMIP controllers and I/O modules supported by an internal UPS
- **Loop Architecture** ensuring system availability in failure events
- **Operational safety** by optimized power and bus management, including open loop detection
- **BUS Coupler Design** providing local operation possibilities
- **Actuator design** of compact electro-hydraulic bus-controlled actuators, designed with connectors for manual casualty cases, allowing functional integrity during temporary flooding and swift replacement

2 VRCS system layout

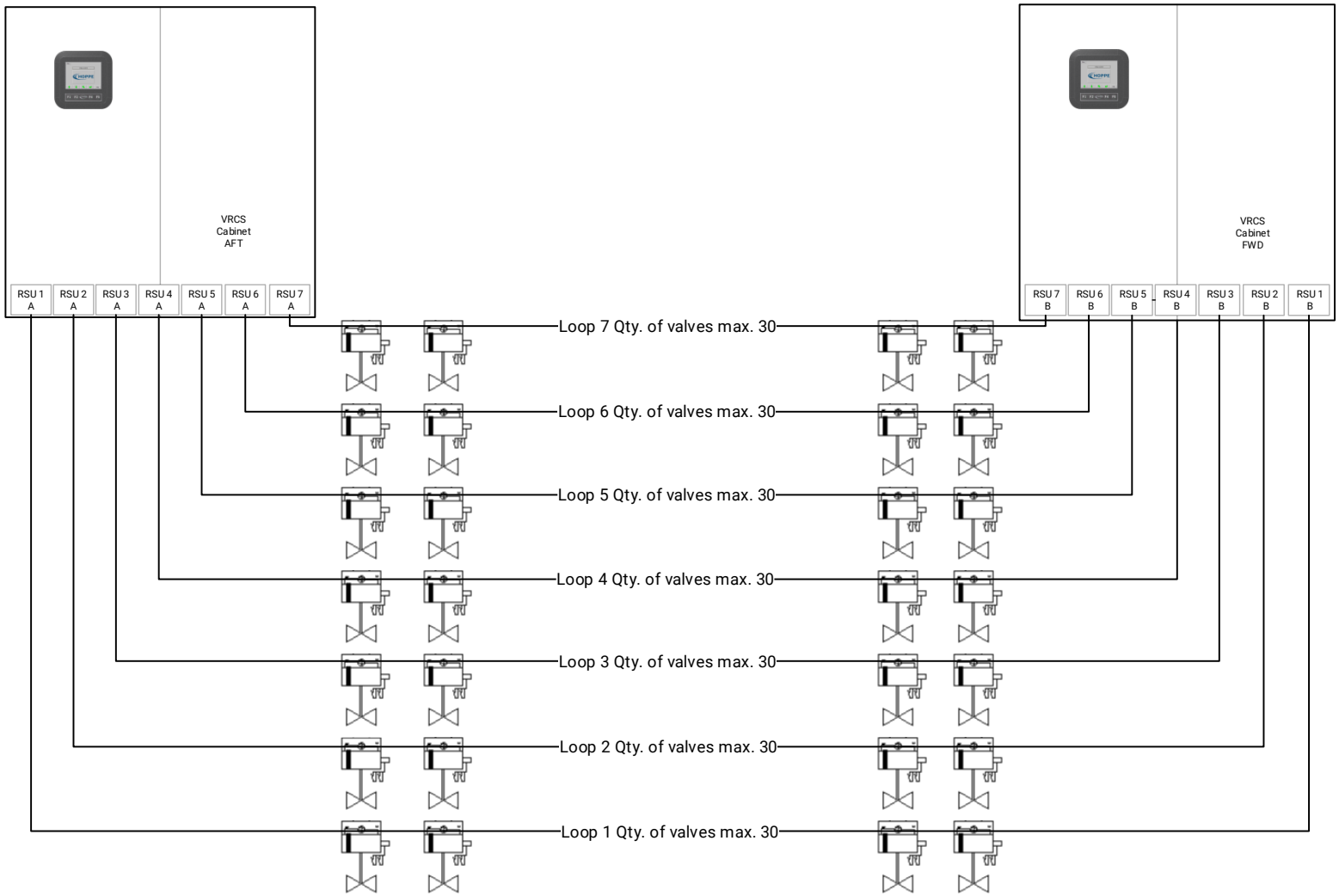


General system layout

2.1 System layout details



Cabinet connections



Valve connections

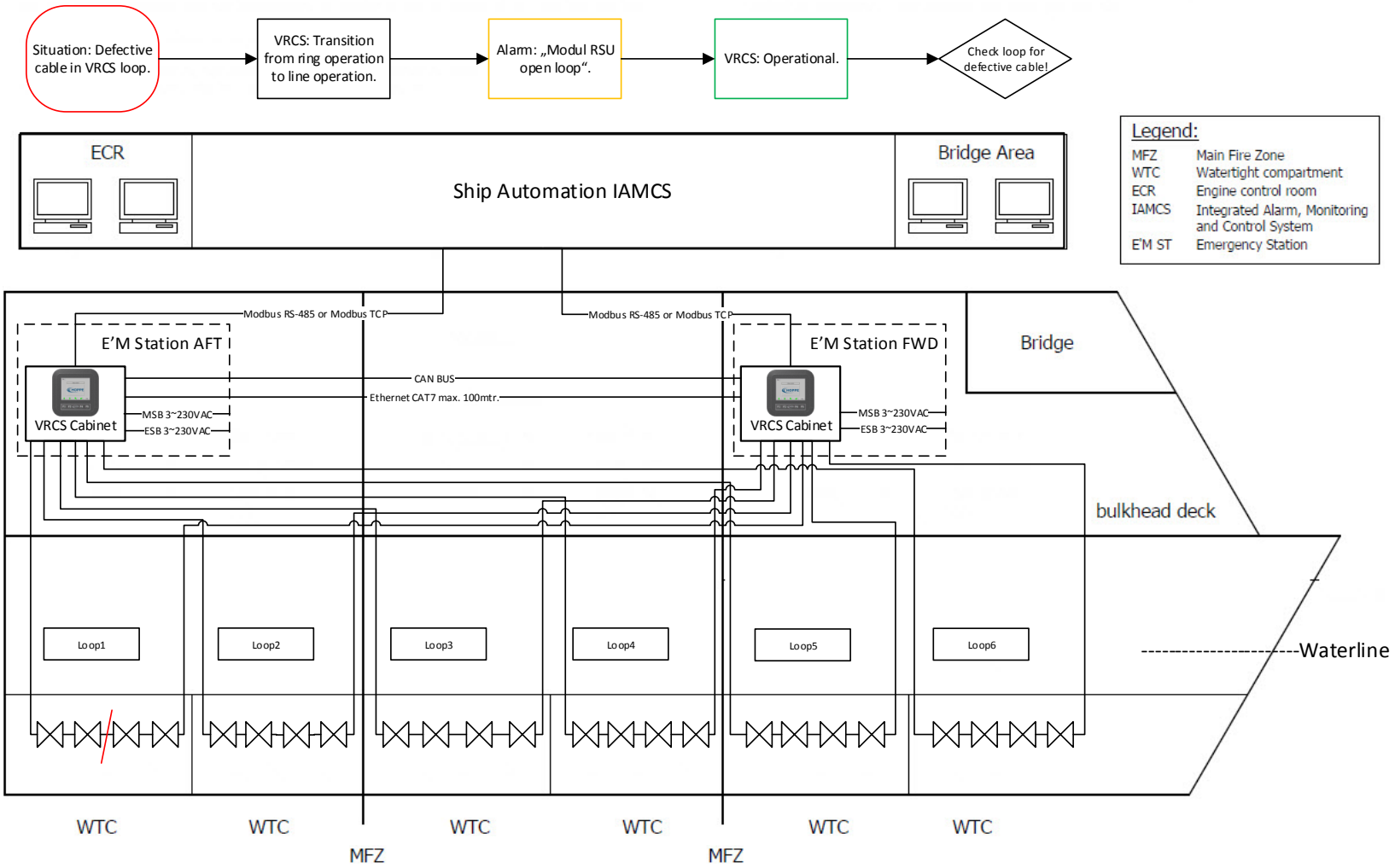
3 System operating levels (top to down)

The HOBUS-V VRCS provides several stages of operating levels in case of casualties.

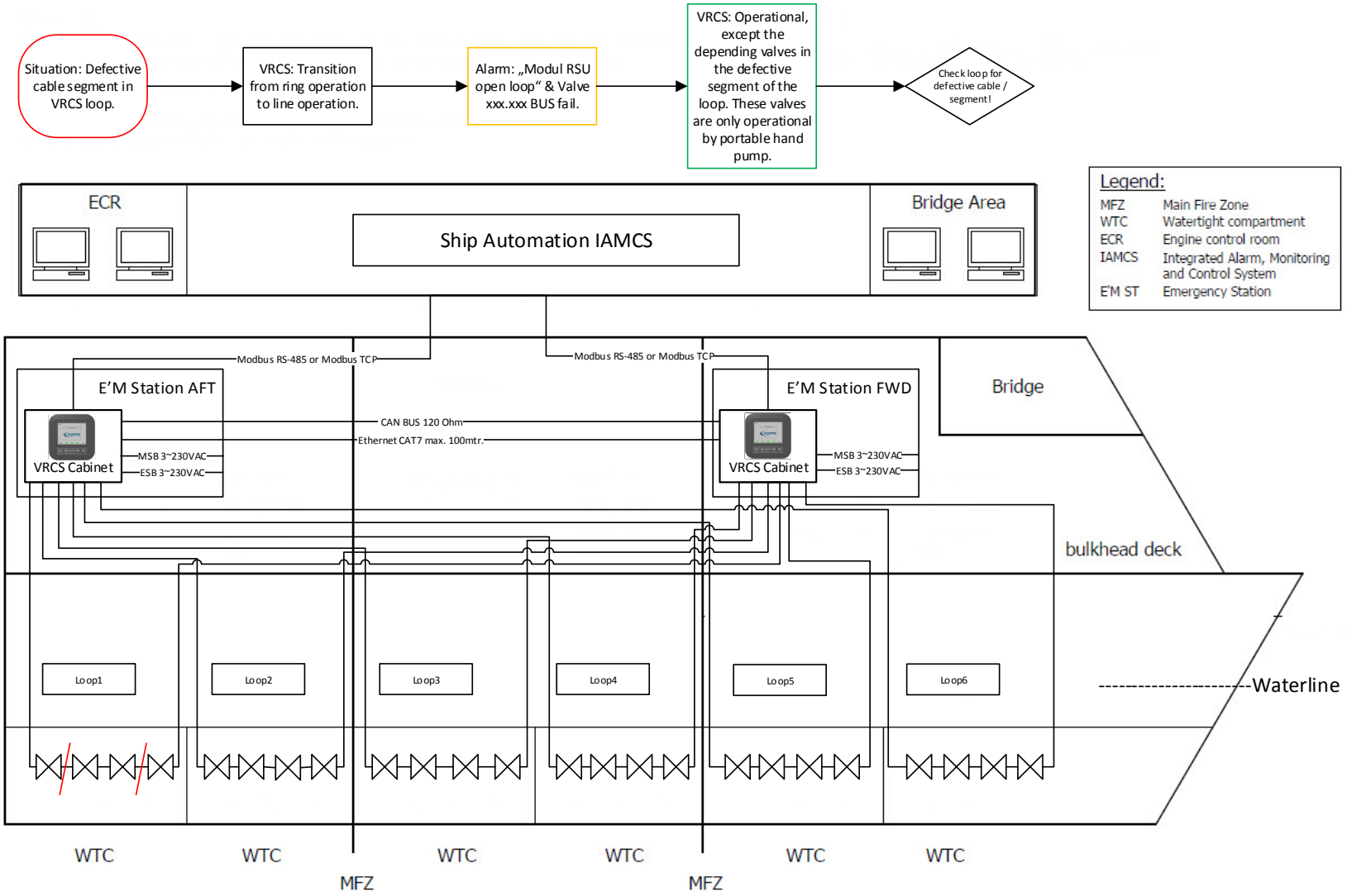
Level	Casualty	Description of functionality level
1	IAMCS: Normal operation	Control and monitoring of VRCS via ships Integrated Alarm, Monitoring and Control System (IAMCS).
2	IAMCS: Interface 1 Fail	Control and monitoring of VRCS with IAMCS via 2nd HOMIP (Hoppe Monitor Interact Process) still possible.
3	IAMCS: Interface 2 Fail	Control and monitoring of VRCS with IAMCS via 1st HOMIP (Hoppe Monitor Interact Process) still possible.
4	IAMCS: Interface 1&2 Fail	Control and monitoring of VRCS via 1st and 2nd HOMIP (Hoppe Monitor Interact Process) still possible.
5	HOMIP 1&2: Fail	Local operation of depending actuator via magnet at bus controller possible.
6	Total loss of power or interfaces	Local operation of depending actuator via hand pump (fixed or portable) possible.

4 Failure routines for various situations

4.1 Loop failures

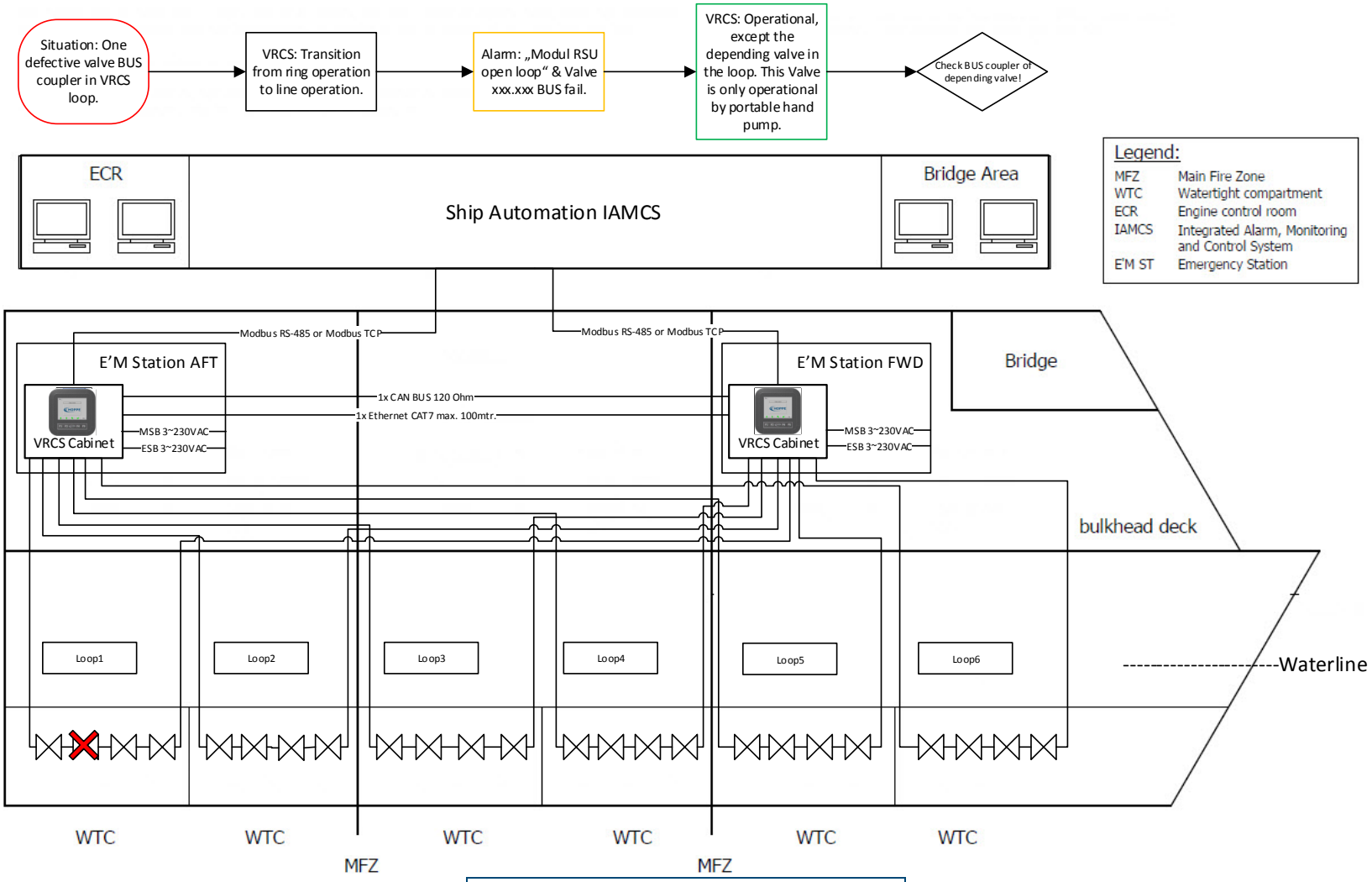


One defective cable connection in a loop

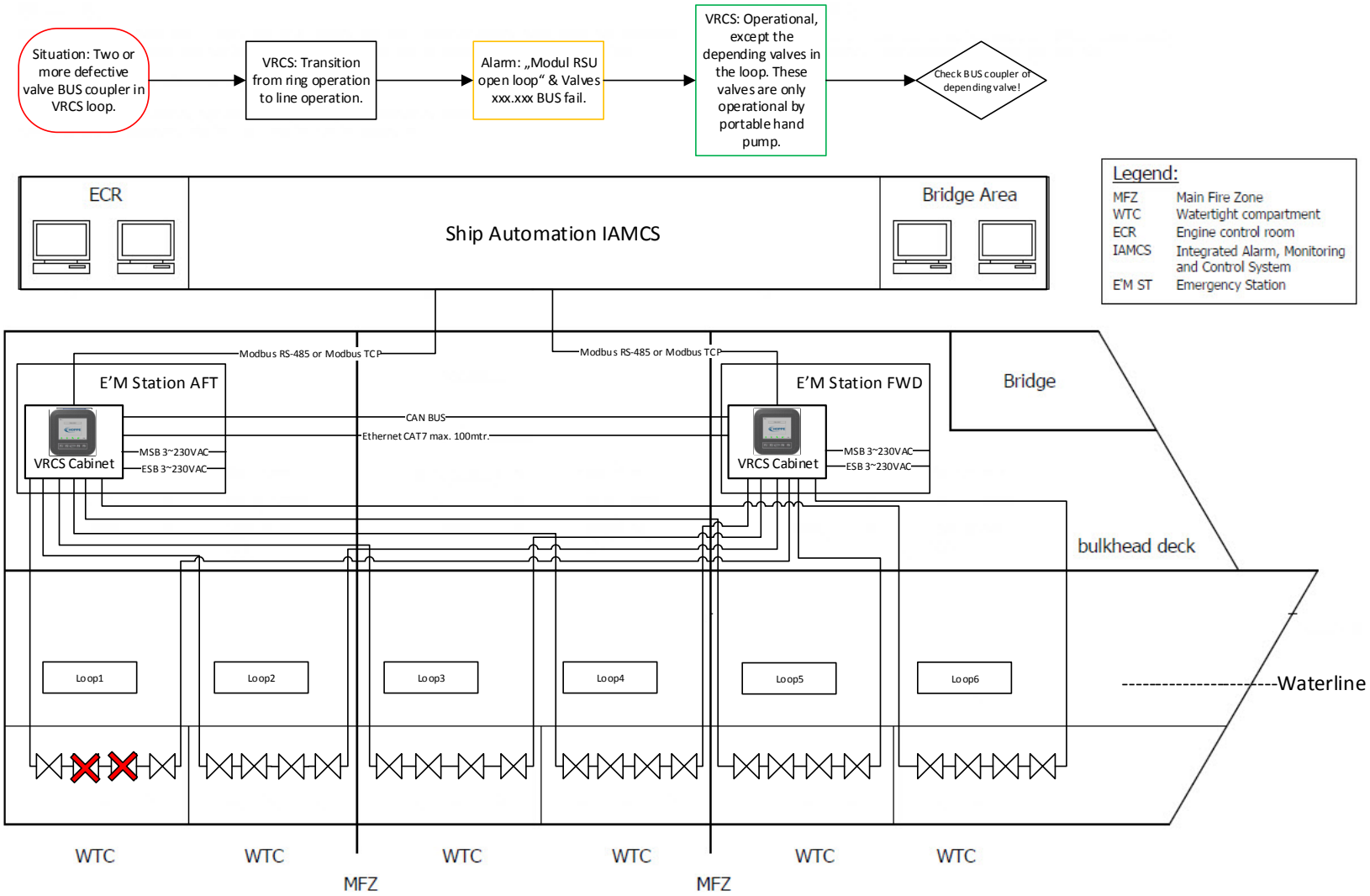


Several defective cables/segment in a loop

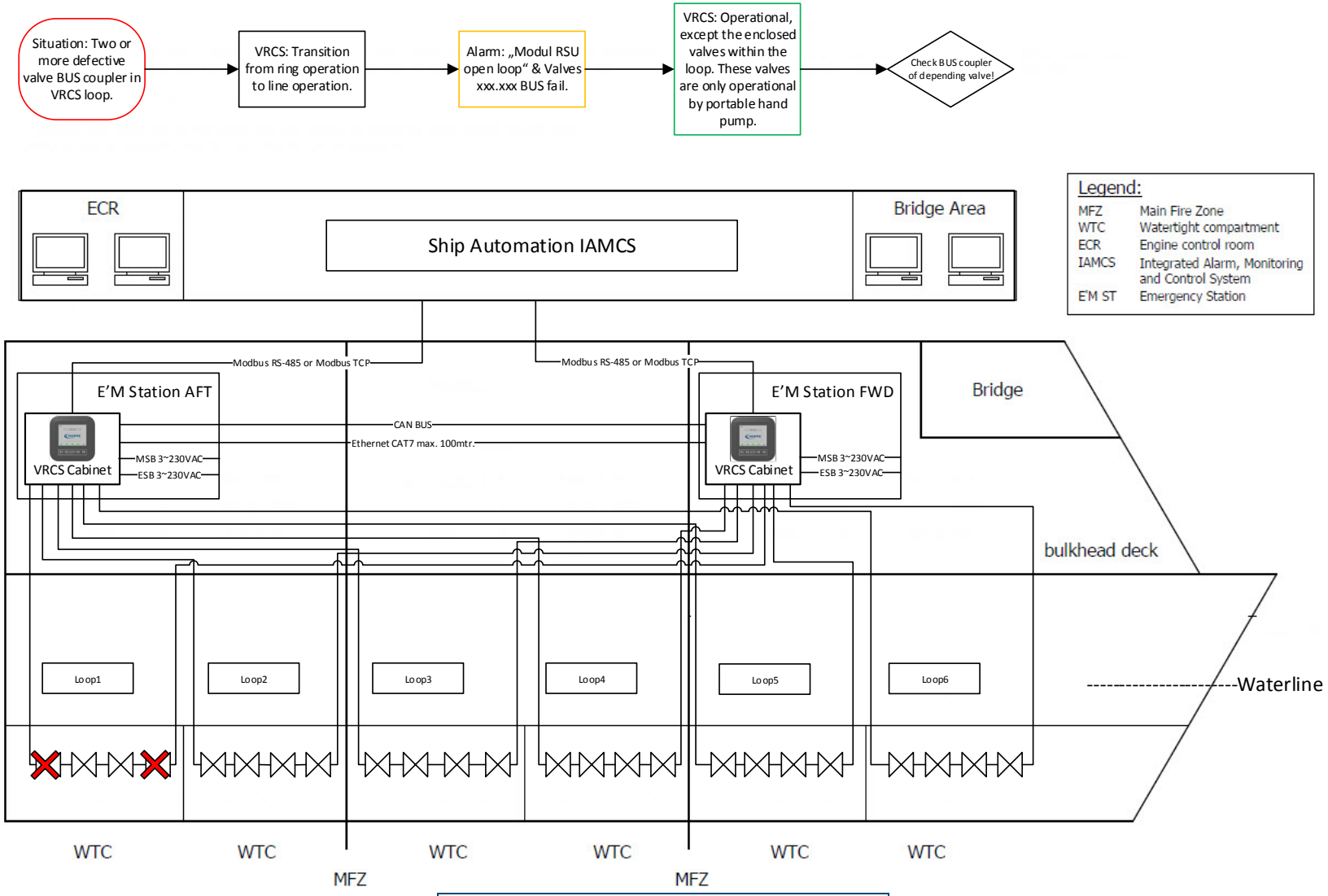
4.2 Valve failures



One defective valve bus coupler within a loop

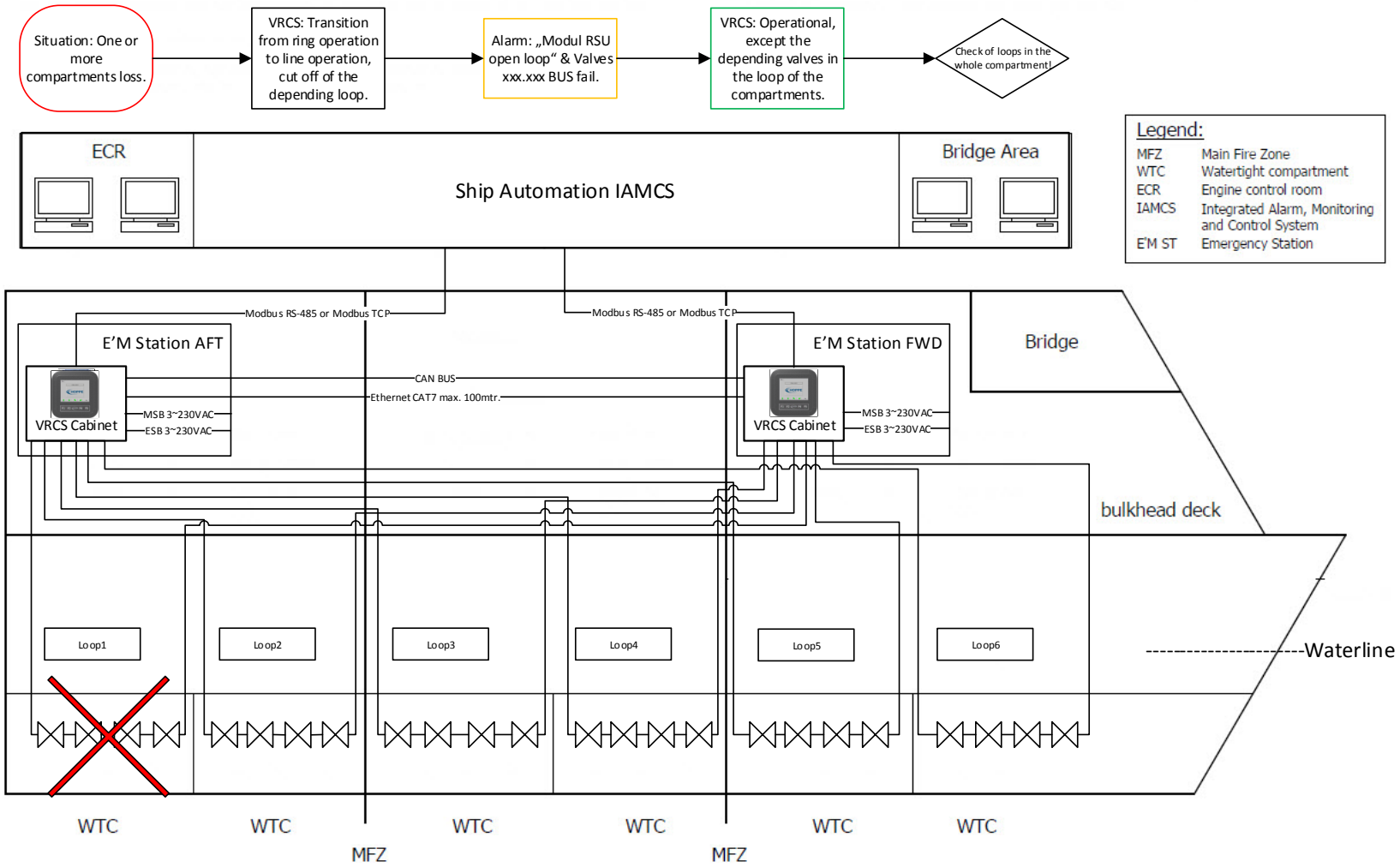


Several defective valve bus couplers within a loop



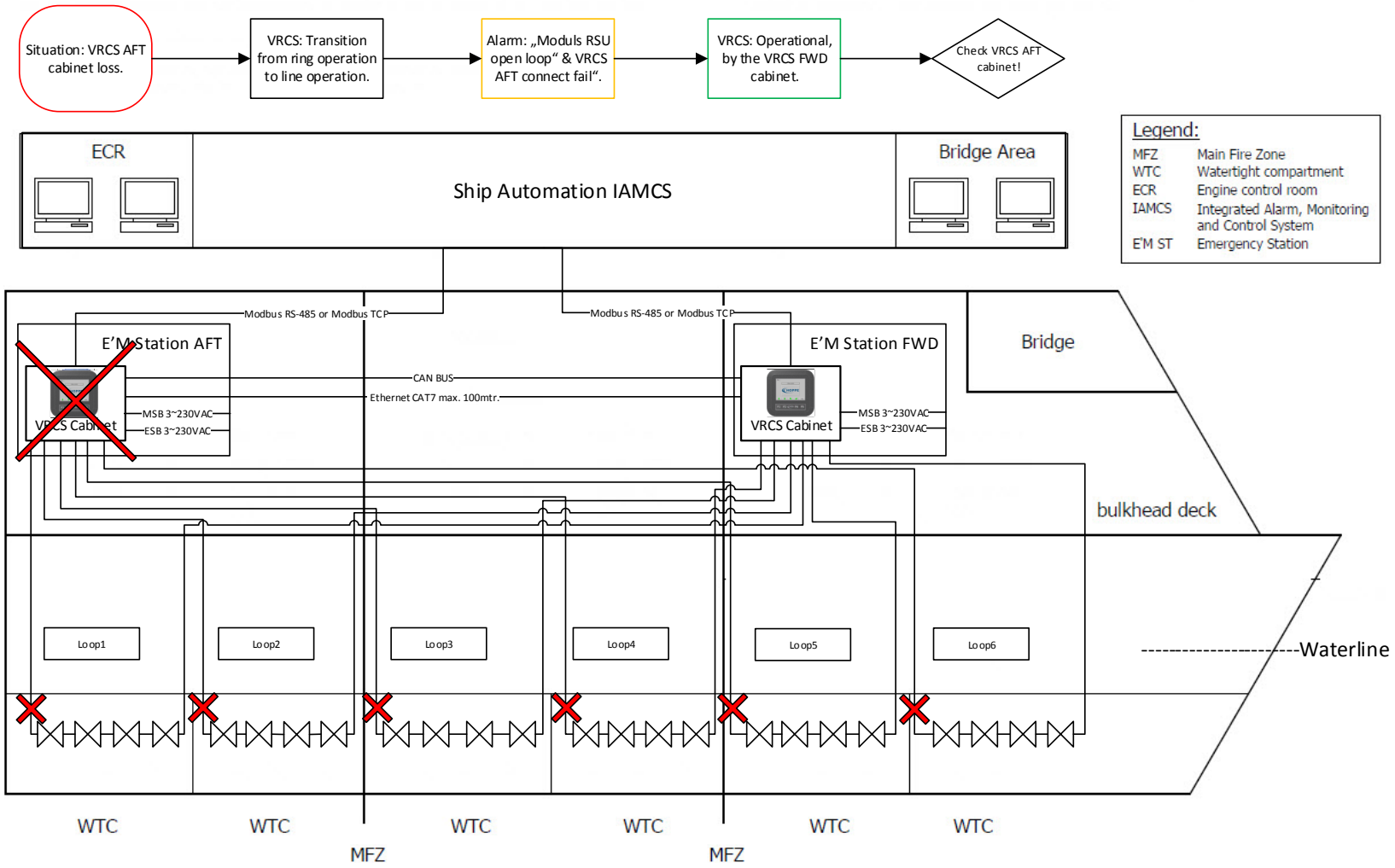
Defective valve bus couplers at loop termination

4.3 Loss of compartment



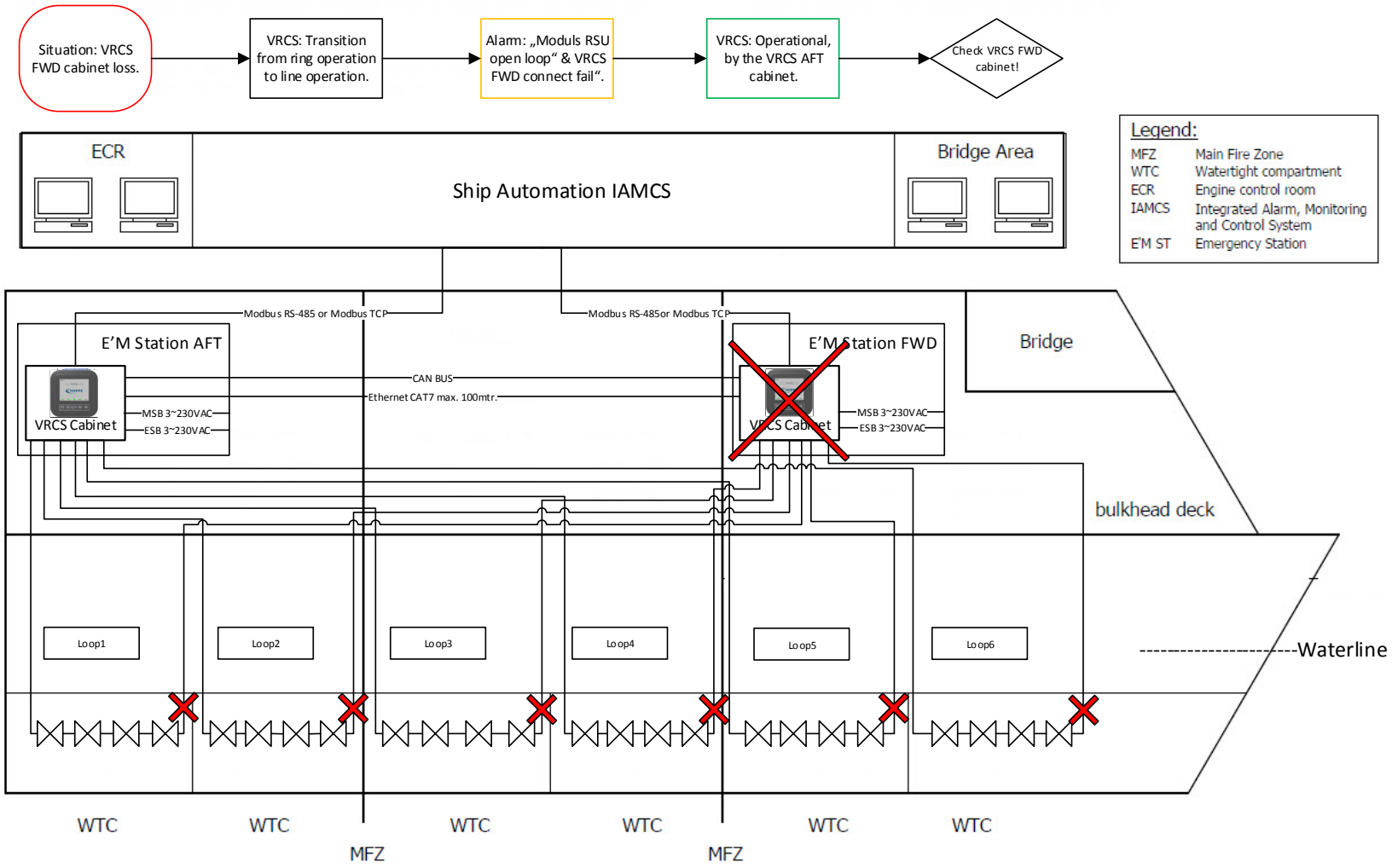
Failure due to loss of compartment

4.4 Loss of VRCS AFT cabinet



Failure due to loss of VRCS AFT cabinet

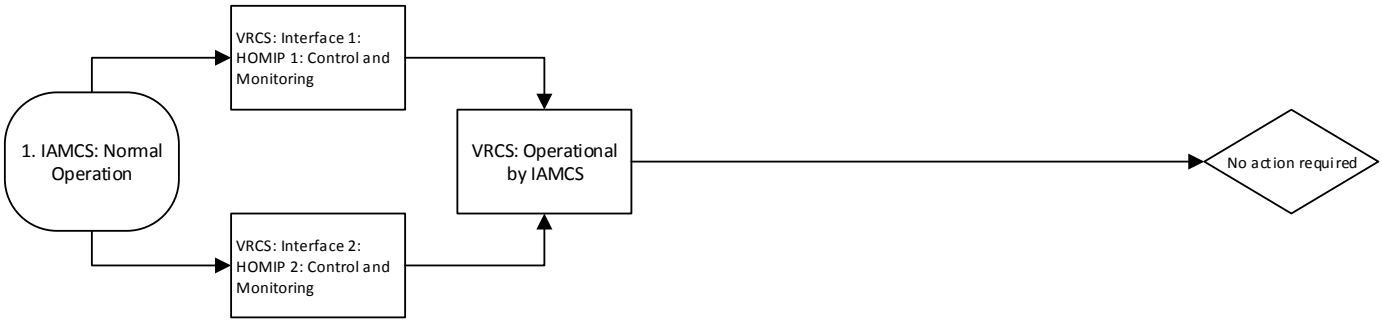
4.5 Loss of VRCS FWD cabinet



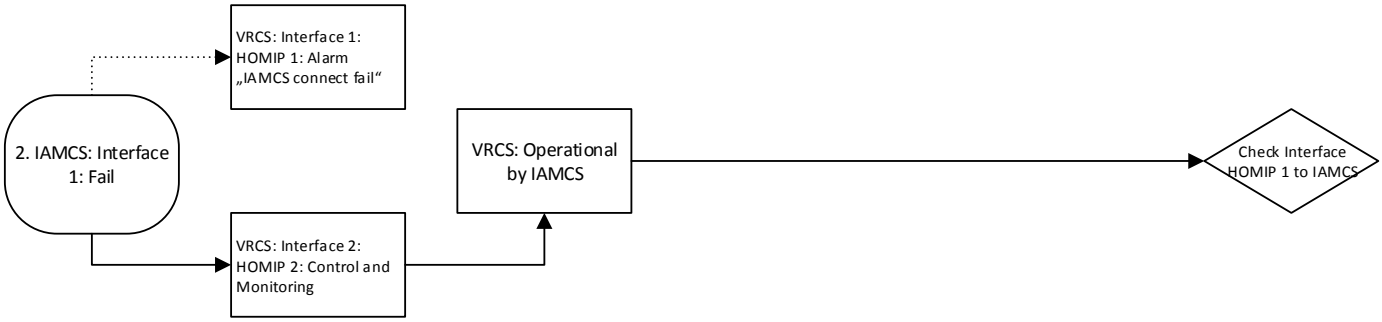
Failure due to loss of VRCS FWD cabinet

4.6 IAMCS interface failure routines depending on casualty levels

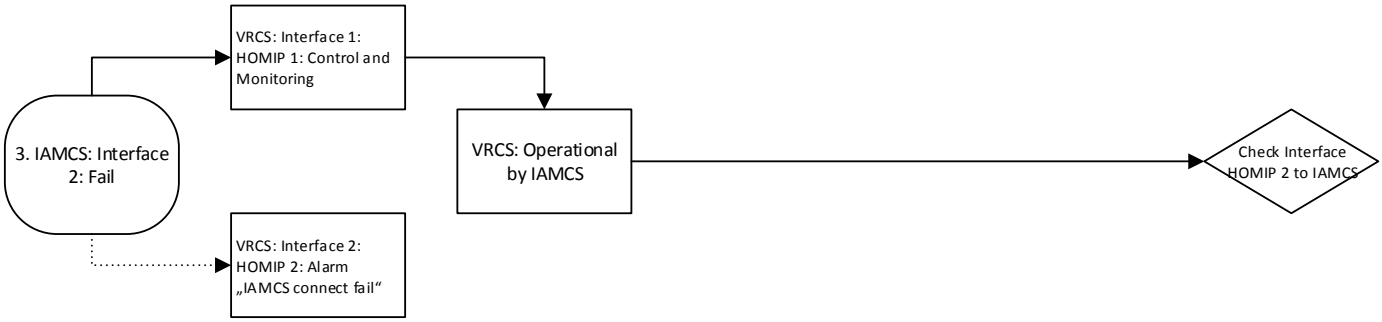
The HOBUS-V VRCS provides several stages of operating levels in case of casualties.



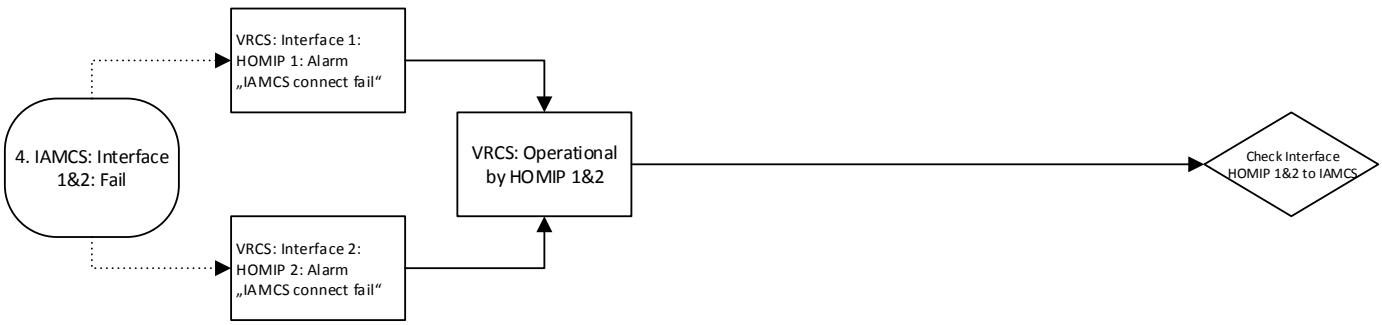
Casualty Level 1



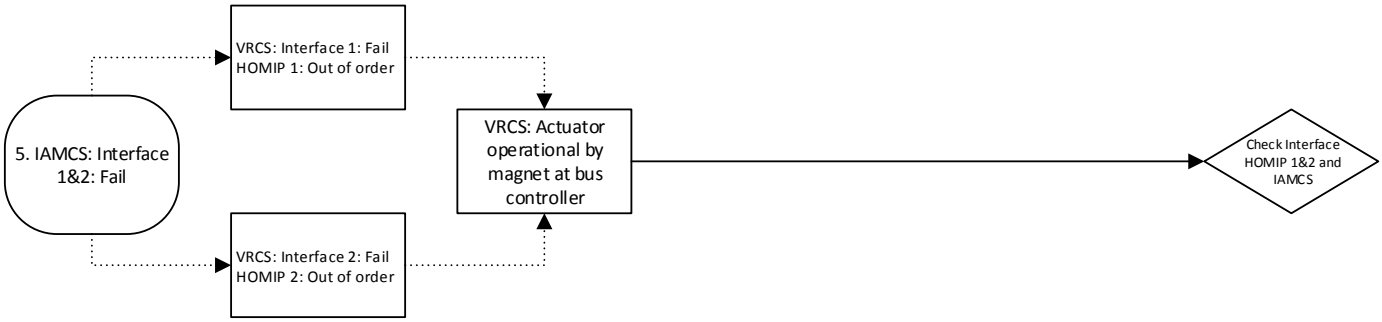
Casualty Level 2



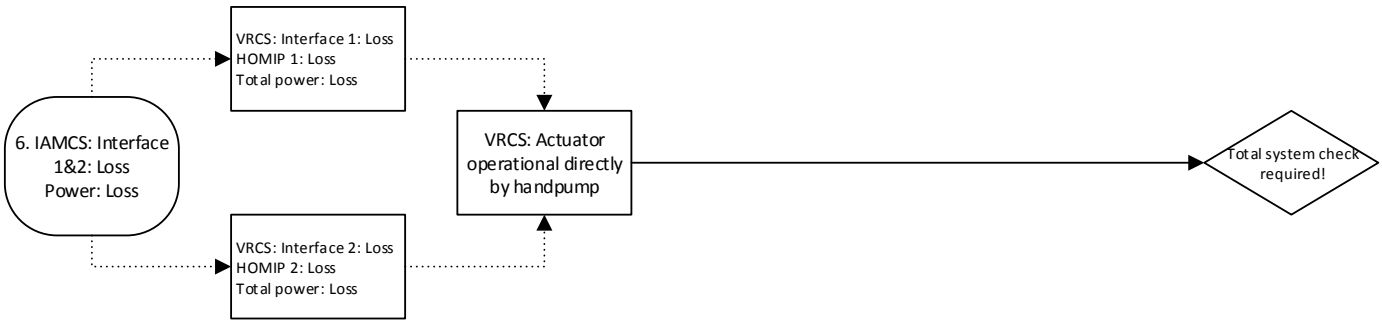
Casualty Level 3



Casualty Level 4



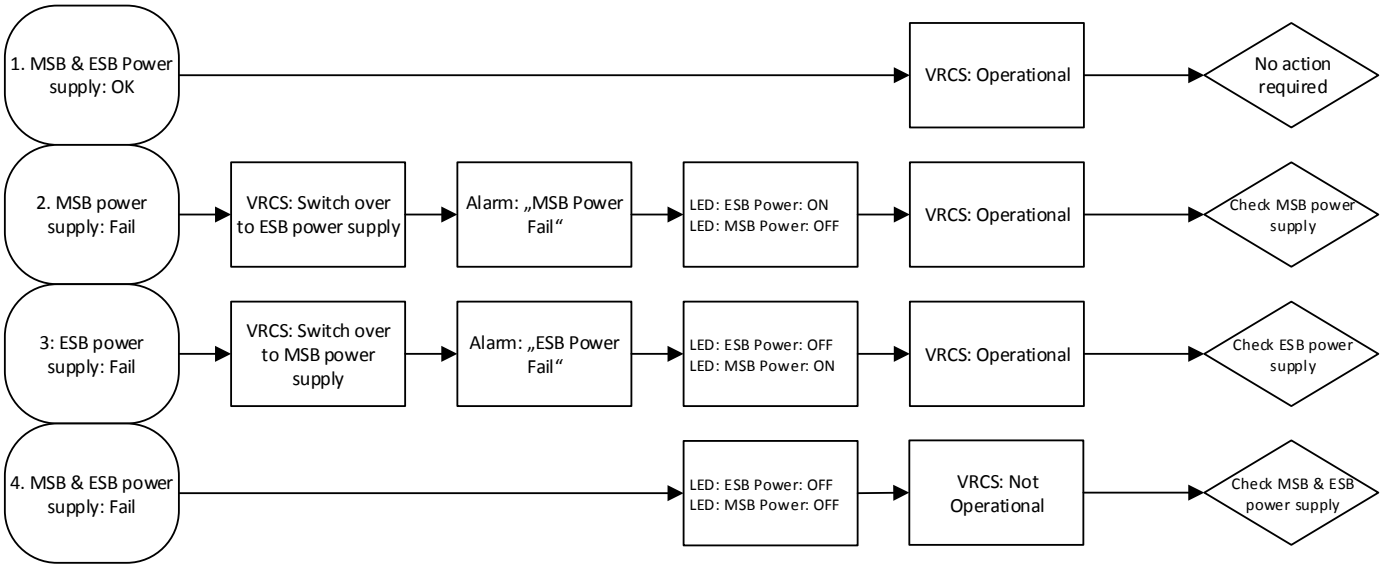
Casualty Level 5



Casualty Level 6

4.7 VRCS failure routines for power supply

The HOBUS-V VRCS provides MSB and ESB power supply including switch over.



VRCS Power Supply Failure