# Final Report
# PP-2308 Dry Dock Block Contact Indicator System

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Rev A

Prepared for:

National Shipbuilding Research Program

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# Contents

## 1. Executive Summary

This is a Research and Development Panel Project accepted by the National Shipbuilding Research Program (NSRP). Panel Projects are project opportunities that are important to the shipbuilding and ship repair industry chosen by the NSRP Executive Control Board.

The results of the project suggest that a block indicator system is very useful for detecting ship contact with the blocks to which the indicator system has been attached. By selecting appropriate blocks, the dock master receives immediate feedback of a vessel touch down on the blocks without requiring the use of divers. This system has the potential to reduce diver necessity.

## 2. Introduction

Divers are often used during drydocking operations. In US Navy drydocking operations, divers are often used in checking alignment before landing, after vessel touchdown to confirm the blocks are properly contacted. If the diver inspection indicates that the blocks are not in properly contact by the vessel being lifted, this is an indication that something has gone wrong. It could be an issue of vessel misalignment, incorrect block construction, or a number of other issues.

Three major challenges that occur when using divers in drydocking is reliability of diver information, lack of visibility for the divers, and diver safety. Unfortunately, a large percentage of dry dock accidents are a result of issues with divers. Miscommunication, lack of knowledge, or confusion of the divers can give a dock master bad information when lifting a vessel. Furthermore, even a well-informed experienced diver can have issues when diving in locations with poor visibility. In some locations, visibility can be as low as six inches. This makes the reliability of divers worse and exposes diving personnel to risk of injury or loss of life. The proposed system could be a less expensive package for obtaining reliable information and reducing divers dive times and dependance.

An additional benefit of this system is to get real time data of the touch down and landing of vessel. With use of hauling blocks, this system gives the ability to see when the hauling blocks are contacting the lifted vessel. Due to safety concerns, divers are unable to be in the water near blocks while they are being hauled, and divers are only used after hauling to confirm contact between the lifted vessel and the hauling block.

This paper describes the use and increased safety during dry docking when using a block contact indicator system as described herein. This paper also briefly discusses the design, components, and installation of the system.

If successful, the project will provide dock masters with more feedback during drydocking and increase safety for the vessel being dry docked and the dry docks themselves.

## 3. System Functionality & Design

The system consists of three main components: The contact detectors, instrument cables, and a microcontroller / user interface unit.

System Functionality

The goal of the system is to place sensors at specific or targeted dry dock blocks so that a dock master can have real-time verification that the vessel being lifted is in contact with the dry dock blocks. The system will be able to detect a vessel as it approaches the blocks within a few inches as well as detect the moment of touchdown and even post-contact crushing of the soft cap.

The information provided by the system is intended to allow the dock master to pause, investigate, and take corrective action if / when the blocks are not loaded as anticipated.

Contact detectors are mounted to the specified blocks (varies per naval architect for each docking) prior to submerging the dock. Once the vessel is within the detectable range, the sensors will contact the vessel will start to actuate the sensors. A micro controller located in the dry dock control room and connected to the sensors by cables will process the sensor information and then make the information available to the dock master on a display. The dock master will then interpret the information to determine what, if any, corrective actions are needed.

Contact Detectors

The first component is a set of linear transmitters (or detectors) that are mounted on blocks. These transmitters are waterproof to at least the maximum depth of the 100 ft. They are designed to detect when a vessel contacts the block, but also allow for overtravel / compression of the block without damaging the vessel, the blocks, or the switches. The exact location of the transmitters will be strategically located to provide full block contact indication. The minimum recommended transmitter locations for a standard ship are the first and last keel block and at least one side block per side of the vessel.

The parts that make up this assembly include the Sensor, spring probe, mount and cable. The probe was made out of HDPE. This is a soft material chosen based on left over material from another NSRP Research Project: PP2318: Alternate Blocking materials. That project explores the use materials other than wood in drydocking.

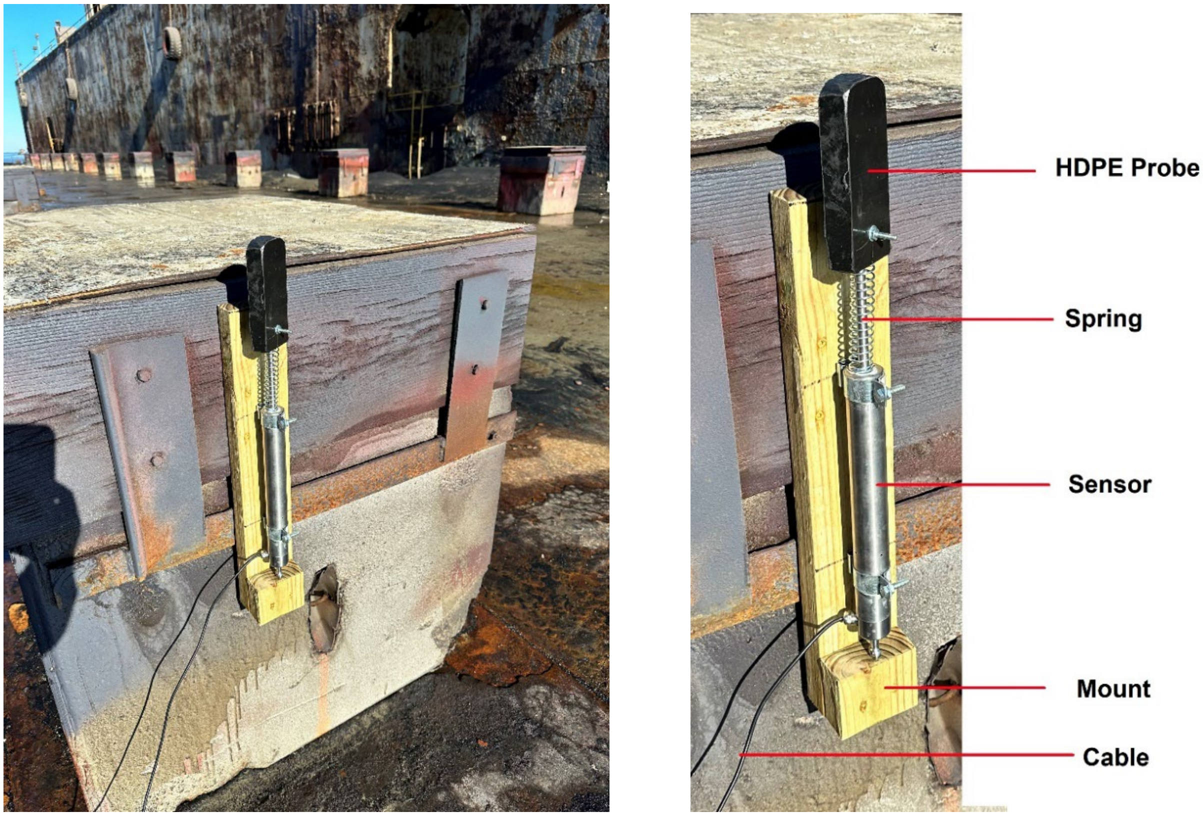


**Figure 1: Installed Sensor**

**Figure 2: Linear Position Sensor Against Ship Hull**

Instrument Cables

The second component is the instrument cables connecting the position transmitter to the microcontroller. The wires are be designed for submergence of the dry dock and secured using cable clips, sandbags, or other means to prevent them from moving during submergence. The system operated on low voltage power (50V or less) so that divers may still operate in the vicinity of the blocks without restriction. Additionally, the cables, while they will be suitable for installation in 'rough service' environments, still need to be suitably protected. Selection of the cable materials and construction together with installation techniques combined with steps to protect the cables will be utilized to enable the use of less expensive non-armored cables.

Micro Controller & Operator Interface Terminal

The third component is the micro controller with attached Operator Interface Terminal indicator board. This device receives signals from the contact indicators. Using these signals, it will process and then display the signals into the dry dock control room.

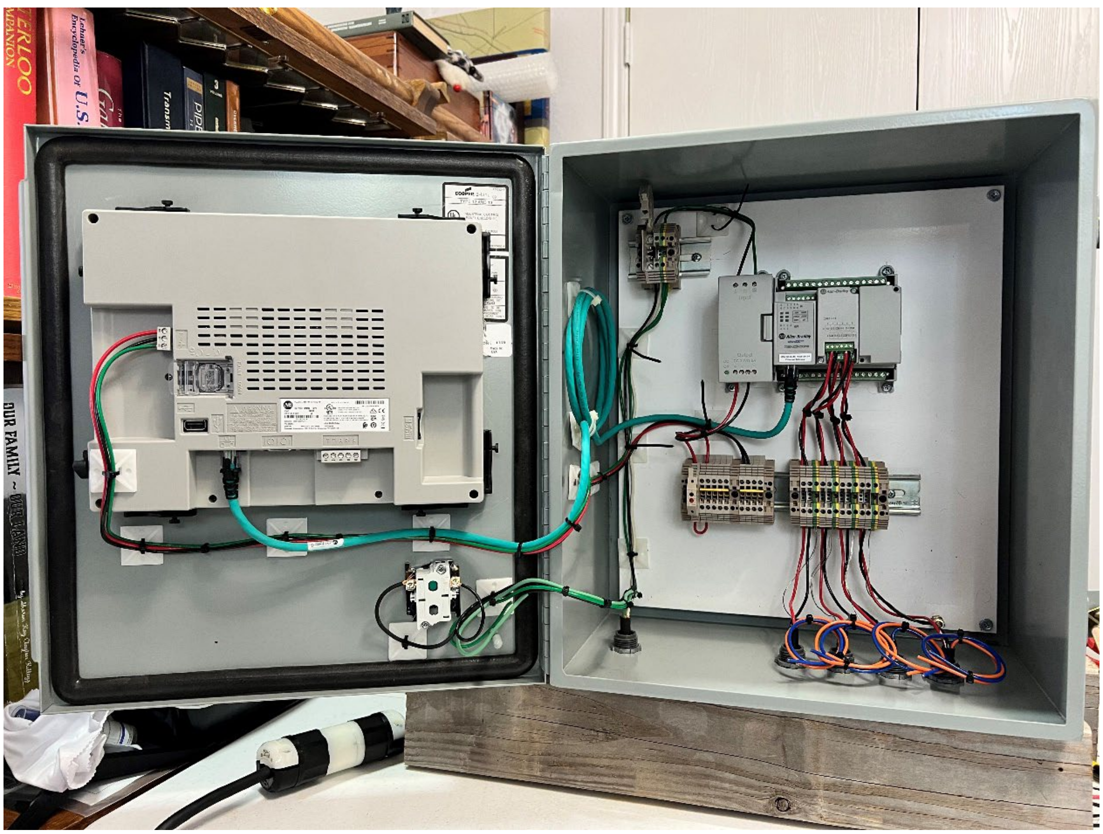

**Figure 3: Microcontroller**

## 4. Procurement Information

The system components ordered to construct the test block contact indictor system.

| Dry Dock Block Indicator System Cost Tracking | | | | |
|---|---|---|---|---|
| **Line No.** | **Description** | **Unit Cost** | **Qty** | **Cost** |
| 1 | Sensors (Linear transmitt | $ 1,425 | 4 | $ 5,700 |
| 2 | Micro 800 PLC | $ 362 | 1 | $ 362 |
| 3 | HMI | $ 2,666 | 1 | $ 2,666 |
| 4 | Power Supply | $ 72 | 1 | $ 72 |
| 5 | Programming Cable | $ 52 | 1 | $ 52 |
| 6 | HMI to PLC Cable | $ 52 | 1 | $ 52 |
| 7 | Analog Input Card | $ 221 | 1 | $ 221 |
| 8 | Misc Cables & Connectors | $ 557 | 1 | $ 557 |
| | **Total Cost** | | | **$ 9,682** |

# 5. Drydockings

## 5.1. RCM 225 Undocking

Vessel Name: Rose Cay Maritime (RCM) 225
Vessel Class: Barge
Vessel Length: 430’
Vessel Undocking Displacement: 7,100 LT
Yard: Gulf Copper Manufacturing Corp., Port Arthur, TX
Dry Dock: GC-9500

The DMC team machines probes and assembles the sensor mounts.

**Figure 4: 1” HDPE stock**

**Figure 5: DMC machining HDPE probe**

The sensors, cables, and HMI are loaded in crates brought to the dry dock. HMI and cables are craned to the top of the wing wall. The cables are then lowered down and attached to the sensors in the basin.

**Figure 6: DMC brings equiptment to GC-9500**

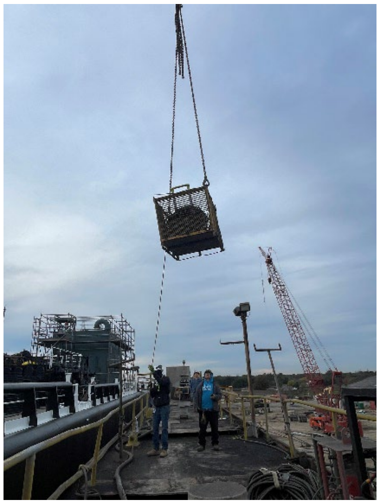

**Figure 7: Craning HMI and cables in basket**

DMC installs the sensors on the blocks.

Figure 8: DMC attaching the sensor to a block.

**Figure 9: Sensor installed on a block.**

The sensors are attached to the blocks in the following configuration:

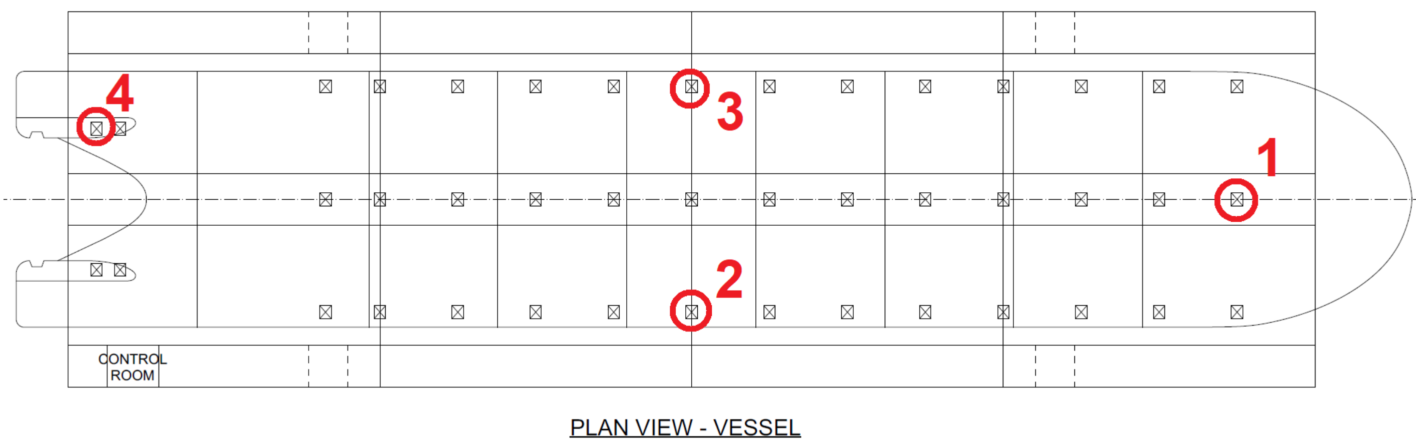


**Figure 10: Blocking plan of the RCM 225 on GC-9500 with circled blocks with sensors, numbered.**

The sensors are all calibrated and installed. The extra cables and HMI are tucked out of the way for line handling. The sensors are calibrated before final installation is completed, so small changes occur giving readings of -5% to +9%.

Figure 11: HMI and Cables on wing wall

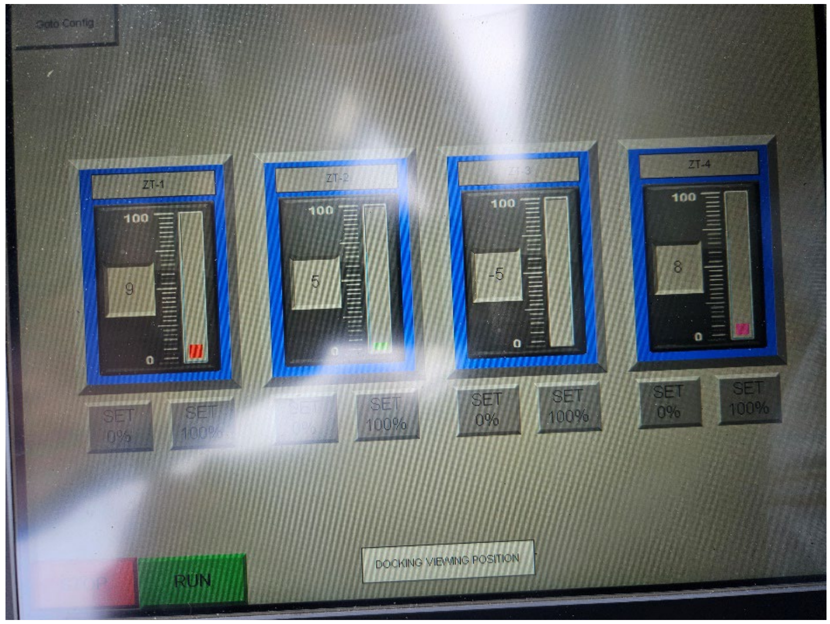


Figure 12: HMI Readout: Initial Readings Pre-Operation

Data is collected, all sensors show over 100% deployment. This is expected as the HDPE probes would float extending the arm further than the spring. The spring has a maximum expansion from 1 in to 5 in, and the maximum sensor extension is 6 in.

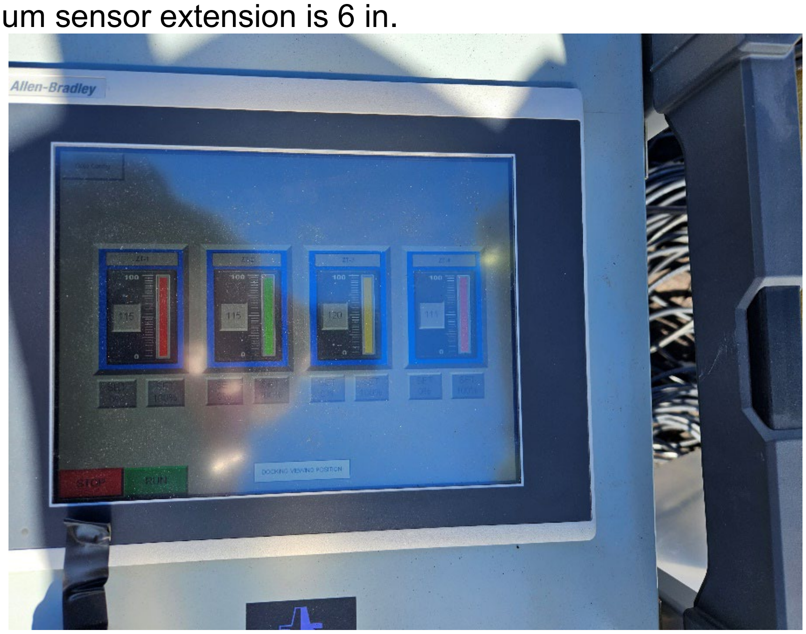


Figure 13: HMI Readout: Post-Operation Final Readings

Post-evolution inspection shows the sensor has deployed under spring power as expected.

**Figure 14: Sensor mounted on the block, showing mechanical extension after undocking.**

Post evolution, the sensors are unexpectedly unresponsive. This connector failure is the suspected cause of the unresponsive sensors. They should have been rated to 100' of depth, and only reached a maximum of 30' throughout the operation.

**Figure 15: Connector condition post undocking. Showing possible water entry.**

The connectors were replaced. The new connectors have a sealing system that will allow their use in over 1000' of depth.

**Figure 16: New connector installed and utilized.**

## 5.2. Brandy Station Docking

Vessel Name: USACE Bandy Station
Vessel Class: Multipurpose Landing Craft / Buoy Tender
Vessel Length: 174’
Vessel Undocking Displacement: 1,416 LT
Yard: Gulf Copper Dry Dock & Rig Repair, Galveston, TX
Dry Dock: GC-4500

Following the failure of the underwater connections, the underwater connection was removed and the sensors were hard wired to the cable. The remainder of the equipment were installed in the same manner as in the previous dry docking.

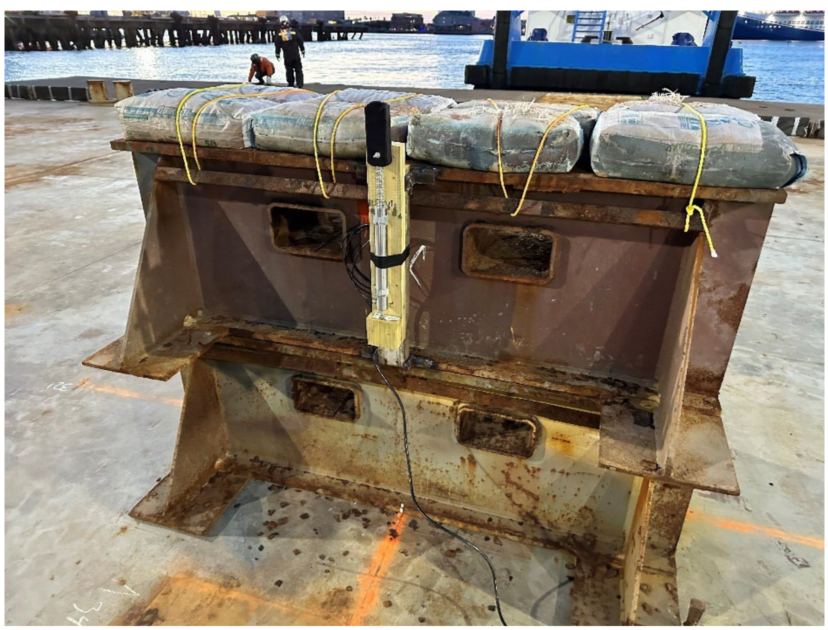

**Figure 17: Keel Block Indicator Installed**

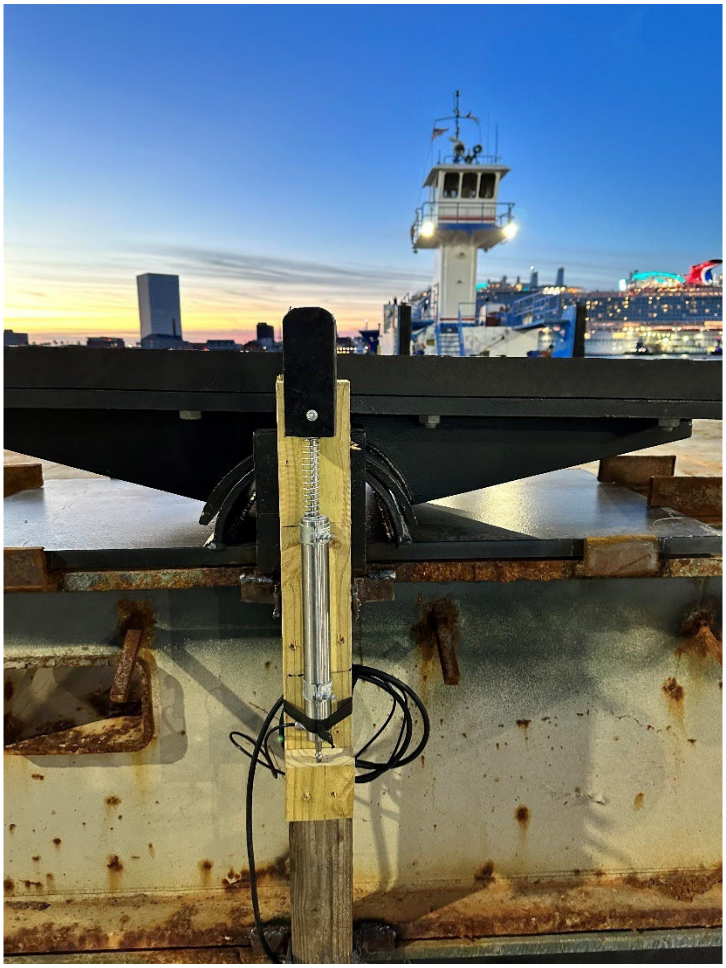
**Figure 18:** Side Block Indicator Installed

The sensors are attached to the blocks in the following configuration:

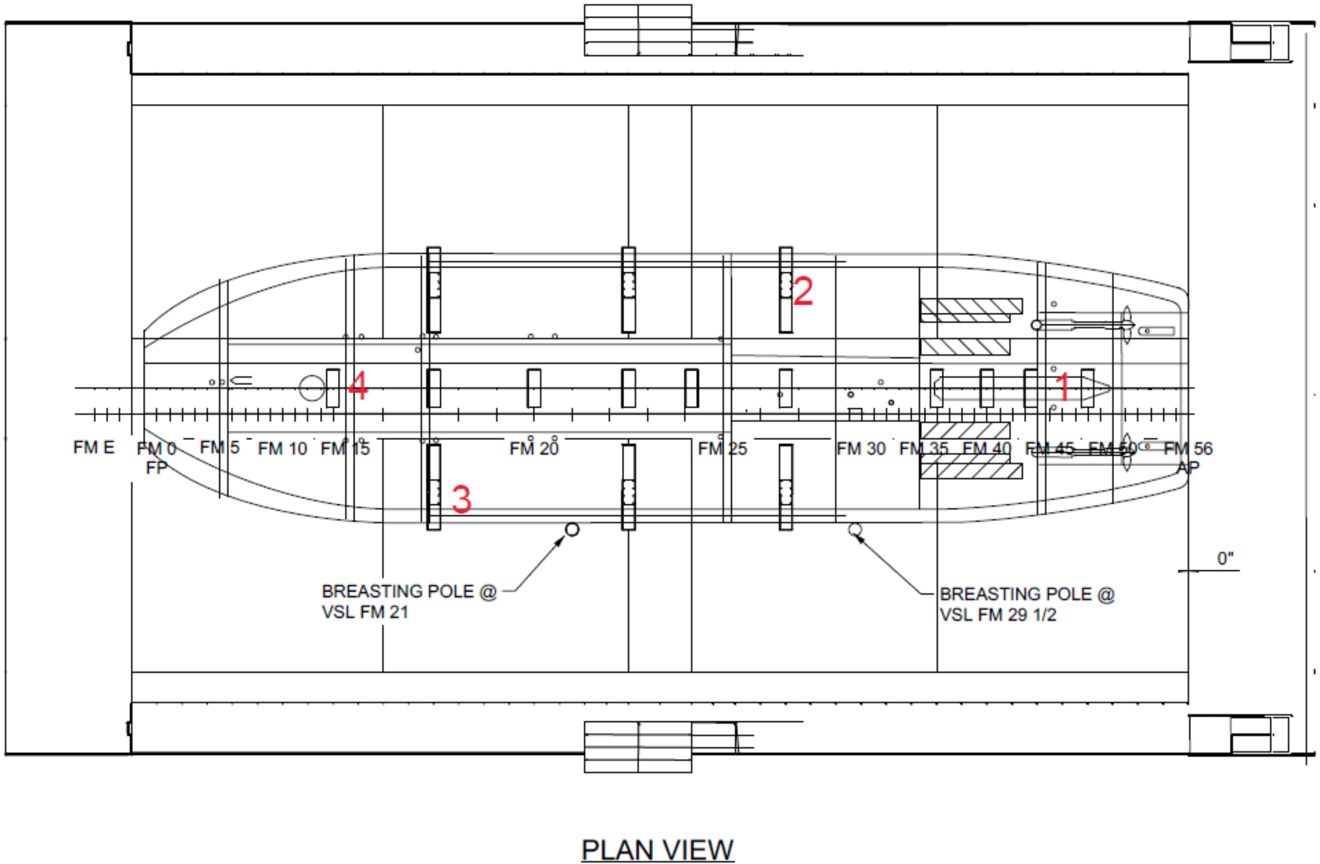


**Figure 19: Blocking plan of the USACE Brandy Station on GC-4500 with sensors numbered.**

The sensors were calibrated and prepared in the same manner as the first dry docking. The sensors indicated 100% deployment. As the vessel approached the blocks, the sensors began to move, indicating that the vessel was approaching the blocks. The time period from not contacting to fully compressed was slightly less than one minute. All indicators moved except for the stern sensor that was supposed to be located on the aft-most keel block.


**Figure 20:** **Sensor Indicator After Touchdown Brandy Station**

Prior to inspecting the dock, the aft sensor was assumed to have some sort of water intrusion failure similar to the first docking. However, after the dock was available for inspection, it was discovered that the vessel was approximately four feet forward of the intended landing point. The system had detected this failure correctly.

**Figure 21:** **Aft Sensor of Brandy Station**

Based on the system response, the system accurately indicated that a failure to contact had taken place during the docking.

## 6. Interpretations of Indications

The following table was developed based on DMC's recommended use of the system assuming a four block indicator layout with a bow, stern, port, and stbd block.

| Indication | Interpretation | Recommended Action |
|---|---|---|
| No blocks indicating | Vessel has not contacted or system is not functioning | Continue pumping. If vessel draft is decreasing, the system is not working. Dock master should proceed assuming system is offline.<br><br>If vessel draft is not decreasing, continue pumping |
| All blocking indicating touchdown | Vessel has contacted all blocks as expected | |
| Stern block indicating but no other block indicating | Vessel has a trim relative to the dry dock and a knuckle reaction is occurring | Pause pumping below the stern and continue pumping at the bow until the bow blocks start indicating |
| Port and / or stern blocks not indicating, stern and bow blocks are indicating | Vessel keel has landed, but the side blocks have not. | Haul in the side blocks more. If not hauling blocks, dispatch a diver to confirm the blocks are not touching. If not touching, abort the docking and increase side block height. |

## 7. Conclusion

In conclusion, several key factors have emerged from this project that are essential for the successful implementation and operation of the block indicator system in drydocking operations.

1. Optimizing installation time through improved methodologies is crucial for efficiency.

2. Providing training for dock masters is vital to ensure the effective utilization and understanding of the system.

3. Thorough confirmation of system functionality through bench testing, field testing, and actual system use is necessary to guarantee reliability.

4. The design of blocking plans to identify key blocks for monitoring aids in understanding the system's operation and enhances its effectiveness.

5. Conducting post-docking inspections to observe switches and wires is essential to confirm the system's service life.

By addressing these key factors, the block indicator system holds significant promise in improving safety and efficiency during drydocking operations.

## 8. Recommended Future Changes

Based on DMC's experience, we recommend the following changes to the system prior to final implementation:

<u>Cables</u>

Although the cables used were serviceable, they were not armored nor crush resistant. The cables were installed as the last component of the system and just prior to submerging the dry dock to minimize the time that the cables were deployed on the dock. Despite numerous discussions and minimized time, personnel were often seen standing on or stepping on the cables. The cables show significant wear on the exterior jacket despite only being used on twice. It is recommended to build future systems with crush resistant cable with a more durable jacket.

<u>Permanent Installation</u>

Based on DMC's limited use, it is very obvious that any dry dock block indicator system should be permanently mounted into the dry dock control room. Furthermore, the instrument cables should be pre-run through a conduit or cable way so that they can be protected during the docking, remain in place between dockings, and be protected from the harsh shipyard environment.

<u>Sensor Mounts</u>

The sensor mounts used were constructed of 2x4 materials. While functional, an aluminum bracket to replace the wood components would have a much longer life in the harsh shipyard environment.

<u>Sensor to Cable Connection</u>

The sensors were hardwired to the cables following the failure of the connection during the first docking. While this functioned for the second docking, installing the sensors and running the cables were made more difficult. The ROV industry has many available cable sub-sea cable connectors. Using these connectors would greatly simplify the installation while not sacrificing the water tightness of the connections. Rather than four 400' long cables, purchasing and making the cables in 100' increments would also simplify the installation without having excessively long amount of cable to festoon.

## 9. Disclaimer

The findings, recommendations, and conclusions presented in this paper are provided for informational purposes only. While every effort has been made to ensure the accuracy and reliability of the information presented, it is important to note that all experimentation and implementation of strategies or solutions proposed by DM Consulting, Inc. should be undertaken at the user's own risk.

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## 10. Distribution

DM Consulting is dedicated to supporting the distribution of this project's information. Below are the efforts of distribution.

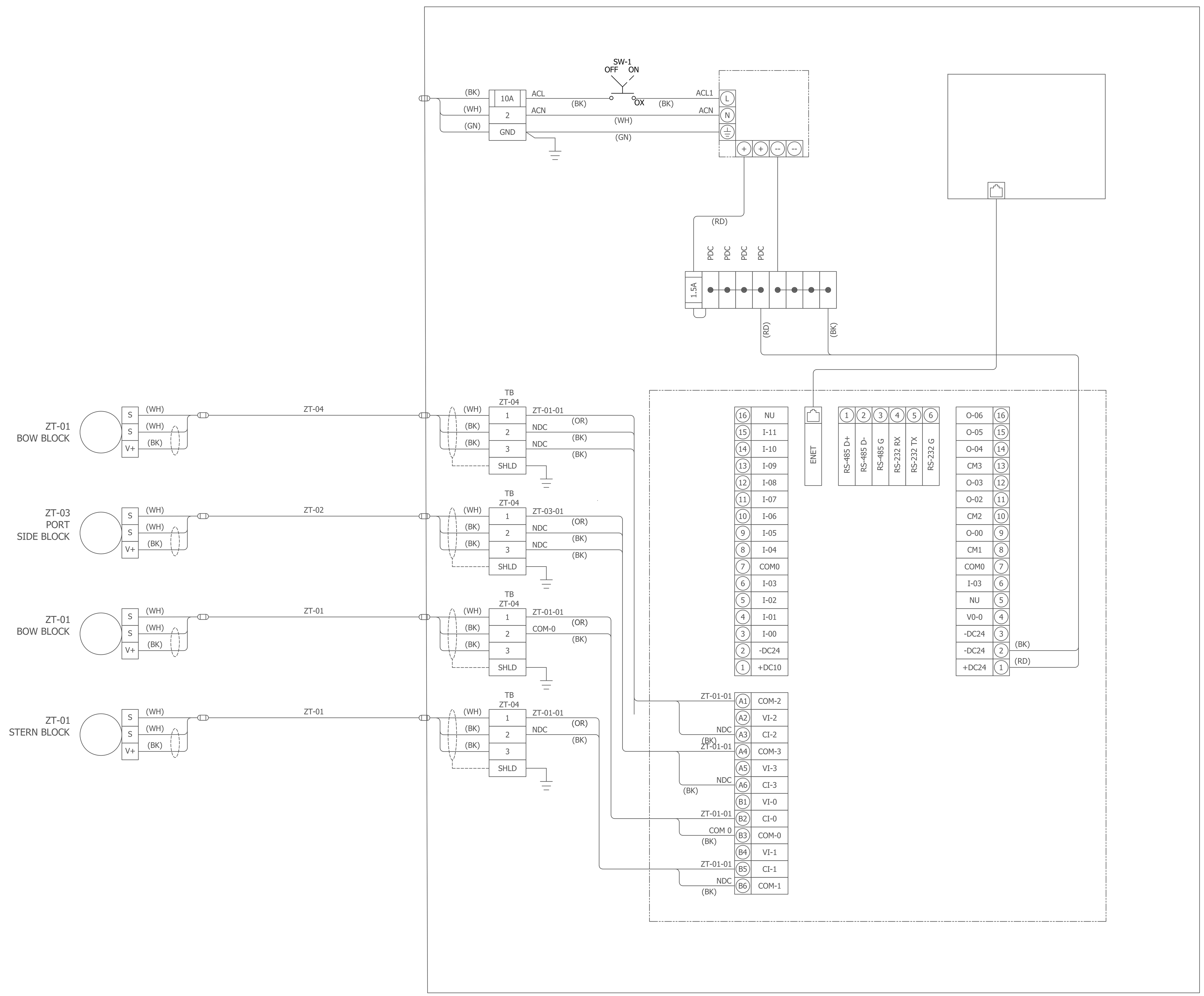
| | |
|---|---|
| March 28-30, 2023 | NSRP All Panels Meeting |
| April 1, 2023 | Dry Dock Quarterly Newsletter |
| April 24-28, 2023 | Dry Dock Training - Asia/Australia/Oceania - Live Online |
| May 8-11, 2023 | Dry Dock Training - Pascagoula, MS, USA |
| June 6-9, 2023 | Dry Dock Training - London, United Kingdom |
| June 13-16, 2023 | Dry Dock Training - London, United Kingdom |
| July 1, 2023 | Dry Dock Quarterly Newsletter |
| October 1, 2023 | Dry Dock Quarterly Newsletter |
| October 23-26, 2023 | Dry Dock Training - North America/South America - Live Online |
| Nov 29-Dec 1, 2023 | WorkBoat Show - New Orleans, LA. USA |
| December 5-8, 2023 | Dry Dock Training - Virginia Beach, VA, USA |
| January 1, 2024 | Dry Dock Quarterly Newsletter |
| February 5-9, 2024 | Dry Dock Training - San Diego, CA, USA |
| March 5-8, 2024 | Dry Dock Training - London, UK - Live Online |
| March 20, 2024 (upcoming) | Final Presentation - Live Online |
| April 1, 2024 (upcoming) | Dry Dock Quarterly Newsletter |

Home Page Updates on our website: www.DryDockTraining.com
Dedicated Project Page on our website: www.DryDockTraining.com/Block-Contact-Indicator.html

## Appendix A. Block Diagrams

The following items are contained within this appendix:

1. Control Panel Wiring Diagram
2. Control Panel Layout



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BOW BLOCK
ZT-03
PORT
SIDE BLOCK
ZT-01
BOW BLOCK
ZT-01
STERN BLOCK
ZT-04
ZT-02
ZT-01
ZT-01
TB
ZT-04
ZT-01-01
ZT-03-01
COM-0
NDC
SHLD
SW-1
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ACL
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CM1
V0-0
+DC24
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CI-2
COM-3
VI-3
CI-3
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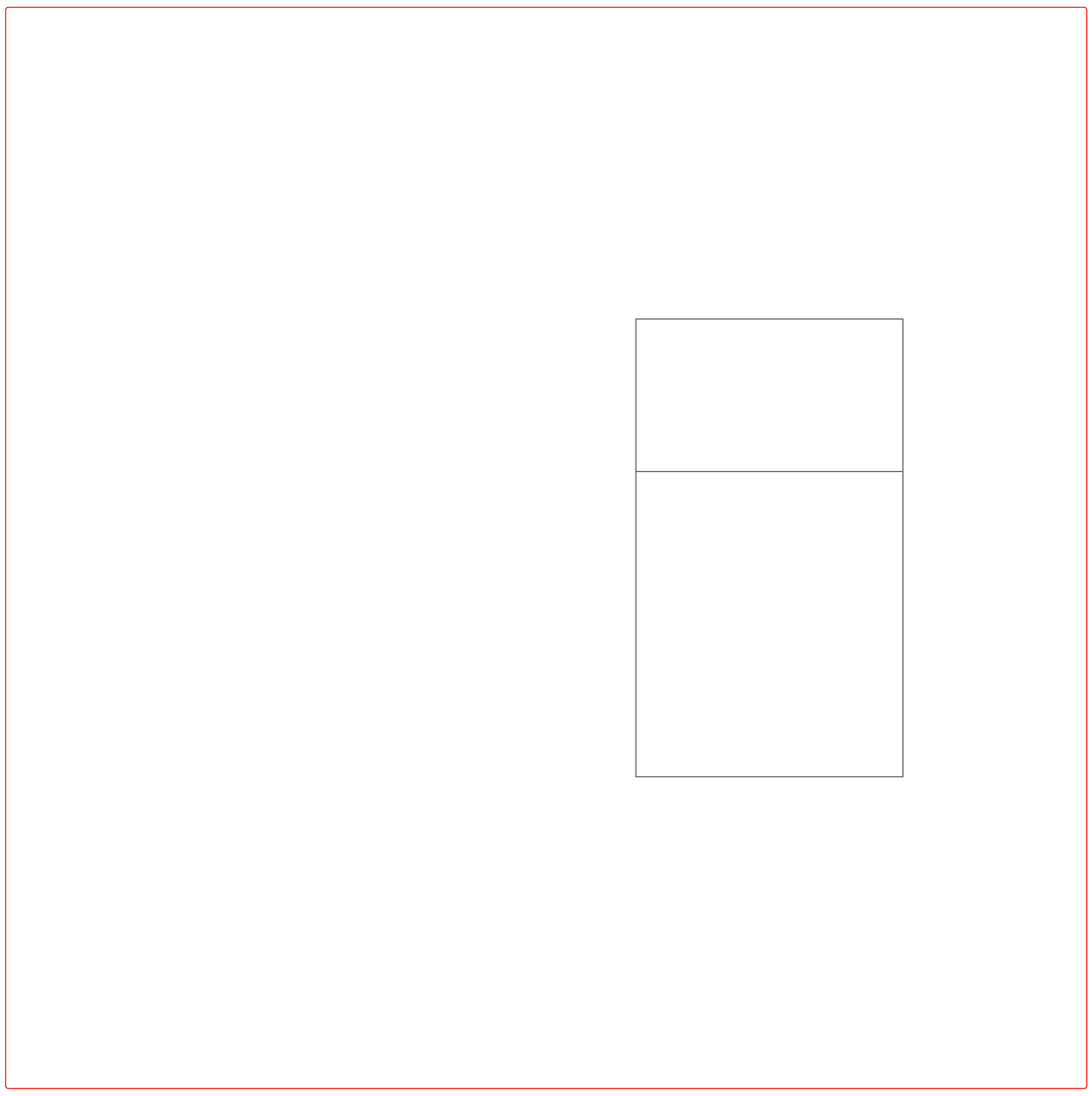

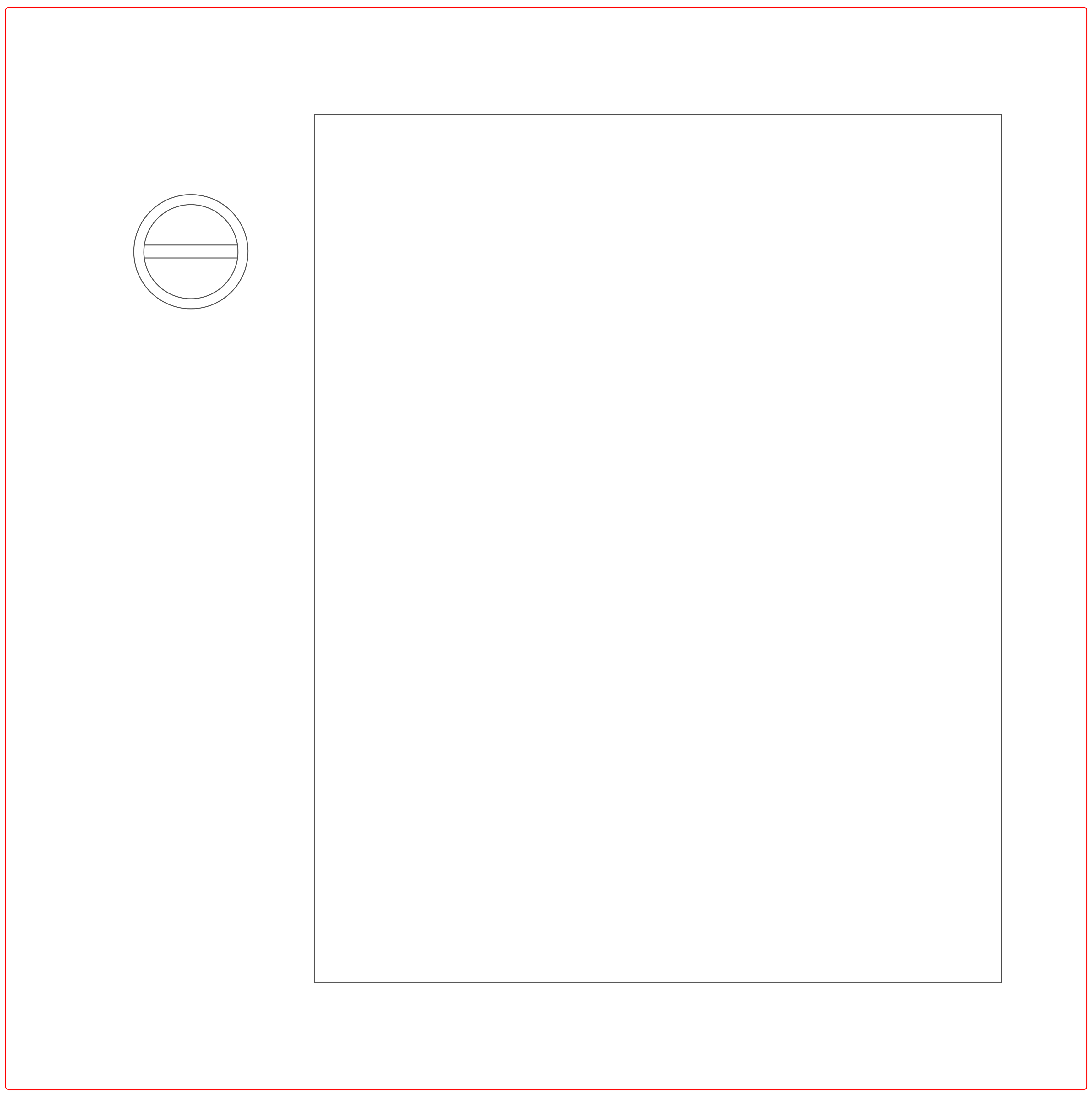

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