MASSACHUSETTS
BAY
TRANSPORTATION
AUTHORITY

Impound Report # 21251

Consist Moved with Person Caught between Doors

ISSUED: 4/21/22

REVISION:

RED LINE ENGINEERING

MBTA Red Line Engineering - Impound Report		Impound # 21251
Subject: Consist Moved with Person Caught in Doors		Train: 1511-10-1614-15-1757-56
Date: 4/21/22	Revised:	Revision:

1.0 Purpose

The purpose of this report is to document the inspection, testing, and action items taken as the result of a person being caught between the E doors of car 1510 at Broadway Station NB.

2.0 Attachments

2.1 Field Notes – Appendix A

2.2 Door Interlock Circuit Explanation – Appendix B

3.0 Reference Material

3.1 Passenger Door Maintenance Procedure - EE&QA #: 52052

4.0 Incident Details:

4.1 Date of Incident: 4/10/22

4.2 Consist: 1511-10-1614-15-1757-56

4.3 Lead Car: 1511

4.4 Location: Broadway Station NB

4.5 Time: 12:30 AM

4.6 Weather: In Tunnel

5.0 Description

The consist led by 1511 was leaving Broadway Station in the NB direction. A person was caught between the E doors on car 1510, pulled along the platform, and dropped into the pit resulting in a fatality.

6.0 Inspection/ Testing/ Findings

6.1 The door control, door magnet, and signal breakers were inspected along with the No Motion and Door Bypass on all cars. The breakers were all found in the "on" position and the bypass switches in "normal".

6.2 The side doors were visually inspected for physical damage and/ or alignment problems with no issues found

6.3 Re-cycle testing was conducted on the E door obstruction systems of 1510 using the standard Red Line test procedure which involved placing a 7/8" diameter dowel at three locations (6" from the top, the middle of the door, 6" from the bottom) and at the bottom using a foot. The doors recycled without an issue.

6.4 The physical condition and working function of the E1 and E2 doors on car 1510 were inspected with all components found in good working order.

6.5 The door interlock and signal systems on each car were tested by attempting to move the 6 car consist via the lead car Cineston controller under each of the following conditions (refer to Field Notes located in the Appendix for details).

- Test Conditions
  - Lead car on the end - Motorman side doors open on all 6 cars
  - Lead car on the end - Guard side doors open on all 6 cars
  - Lead car on the end - Doors on both sides open on all 6 cars
  - Lead car in the middle - Doors forward open and rear doors closed
  - Lead car in the middle - Doors forward closed and rear doors open
  - Lead car on the end - Continuously recycling the E2 door of car 1510 using the standard 7/8" diameter test dowel.

- Lead car on the end - Continuously recycling the E2 door of car 1510 using a fire extinguisher to simulate a larger object.

- Results
  - The interlock relay on end car 1511 "picked" (contacts closed) with the doors closed/ locked and "dropped" (contacts open) with a door or multiple doors unlocked/open per design. The consist, however, was able to move via the Cineston controller of car 1511 regardless of interlock contact position.
  - The door interlock on end car 1756 was found in good working order.
  - Interlock testing on the middle cars produced invalid results. The door interlock circuit was designed to function from an end car only, therefore each married pair should have been separated and each car tested as a lead.

6.6 The married pairs were separated, and the door interlocks tested on each car of each pair.

- The door interlock on car 1511 was not functioning properly and the married pair moved via the Cineston controller of 1511 with the interlock contacts open and the doors unlocked/ open.
- The interlock systems on the rest of the cars were found in good working order.

7.0 Troubleshooting/ Findings (see figures 1 & 2)

7.1 Each connection of the door interlock system of car 1511 was inspected with voltages measured.

7.2 When the Cineston Controller was "keyed on" and in a power position (1st, 2nd, 3rd, or 4th notch), voltage was found on the propulsion power trainlines whether the door interlock contacts were open or closed.

7.3 The P3 breaker supplies power the propulsion Cineston reverser (forward or reverse) and the power trainlines via the door interlock, B3A contact stud, and finger contacts. The P3 breaker also supplies power to the brake trainline via the B3 contact stud and finger contact. Since voltage was found at B3A regardless of door interlock contact position, each connection of this circuit was inspected for improper wiring, chafing, and/ or broken connections.

7.4 The B3.4 wire, which is attached to the B3 contact stud on the Cineston left terminal block, was found chafed and shorted to the B3A finger mounting screw (figure 2). The mounting screw is not insulated by design from the B3A finger contact.

- A finger contact bridges two side by side contact studs on the Cineston terminal. When the Cineston is rotated into a power position, the B3A finger contact "bridges" voltage between the B3A and B3C contact studs. The B3C contact stud then connects voltage to each power stud contact via jumpers. The voltages are then "bridged" from the power stud contacts to the associated trainline by finger contacts actuated by the Cineston power position selected.

7.5 The short from B3 to B3A acted like a jumper across the door interlock contacts when the Cineston controller was in a power position. Voltage was always applied to the reverser contacts and propulsion power finger contacts regardless of side door and interlock status.

MBTA Red Line Engineering - Impound Report		Impound # 21251
Subject: Consist Moved with Person Caught in Doors		Train: 1511-10-1614-15-1757-56
Date: 4/21/22	Revised:	Revision:

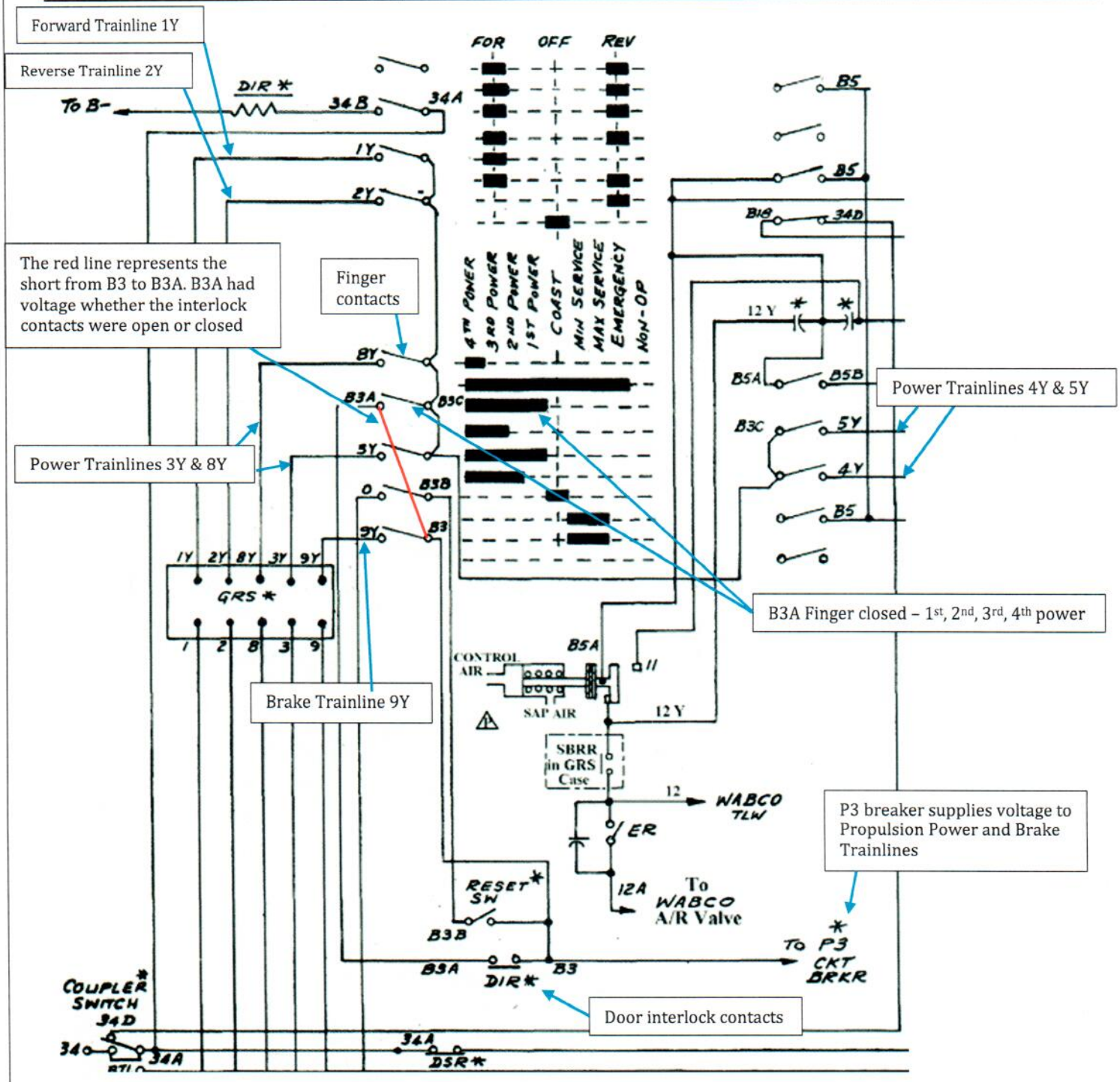


Figure 1: Cineston Controller wiring schematic – Short from B3.4 Wire to the B3A finger mounting

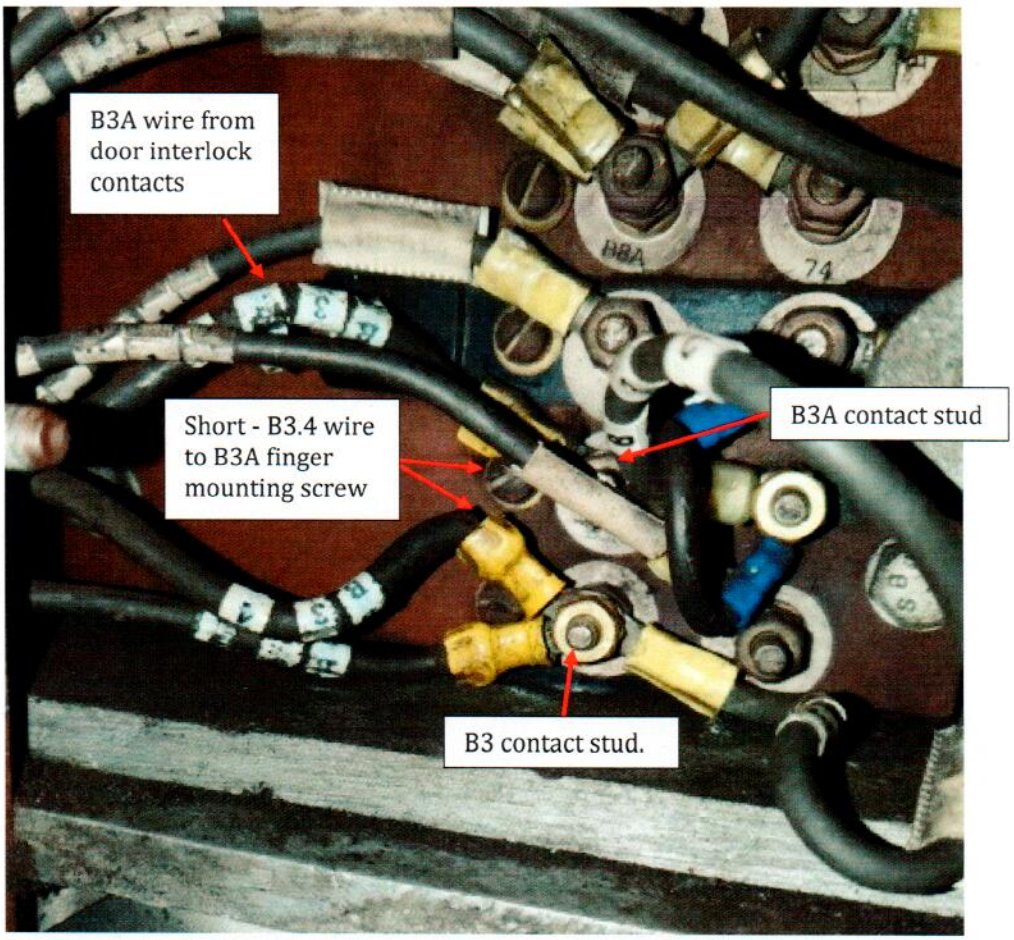


Figure 2: Cineston Controller left side terminal wiring – B3.4 shorted to the B3A finger mounting screw

8.0 Conclusion

8.1 The short from the B3.4 power wire to the B3A finger mounting screw on the left terminal of the Cineston controller in car 1511 bypassed the door interlock contacts allowing the consist to move via the Cineston in car 1511 regardless of side door status.

9.0 Action Items

9.1 The door obstruction systems and interlock systems on the entire fleet of 1500 and 1600 series trains were tested by recycling doors and attempting to move the train via the Cineston controller with doors open.

9.2 The Mileage Inspection procedure has been updated to add "notching" the train (1st power ~ 1 foot) via the Cineston controller of each car with a door open as a final check. The previous version tested the door interlock of each car but did not include "notching".

10.0 Next Steps

10.1 The following repair procedure to be completed on the entire fleet of 1500 and 1600 series trains (figures 3 & 4).

- Each connection on the B3 contact stud will be removed and a 2" long piece of 3M heat shrink was installed over the end of each crimp connector and wire.
- A jam nut was installed on the B3 contact stud to push the B3 wire connectors away from the B3A and B3 finger mounting screws.
- Electrically isolating Liquid Tape was used to cover the entire heads of the B3A and B3 finger mounting screws.
- The function of the door interlock to be verified for proper operation after the repair.

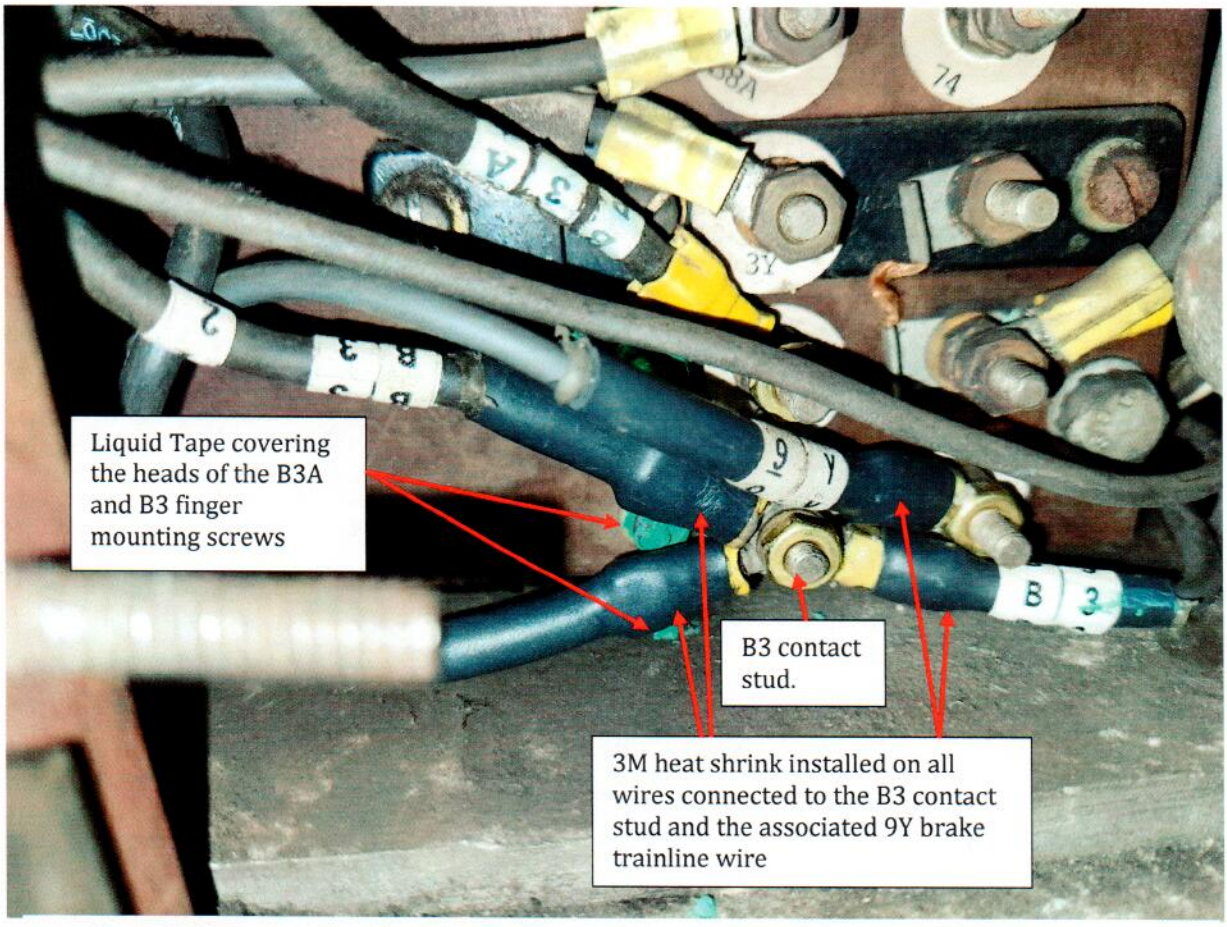


Figure 3: Cineston Controller left side terminal wiring – heat shrink applied to B3 power wires

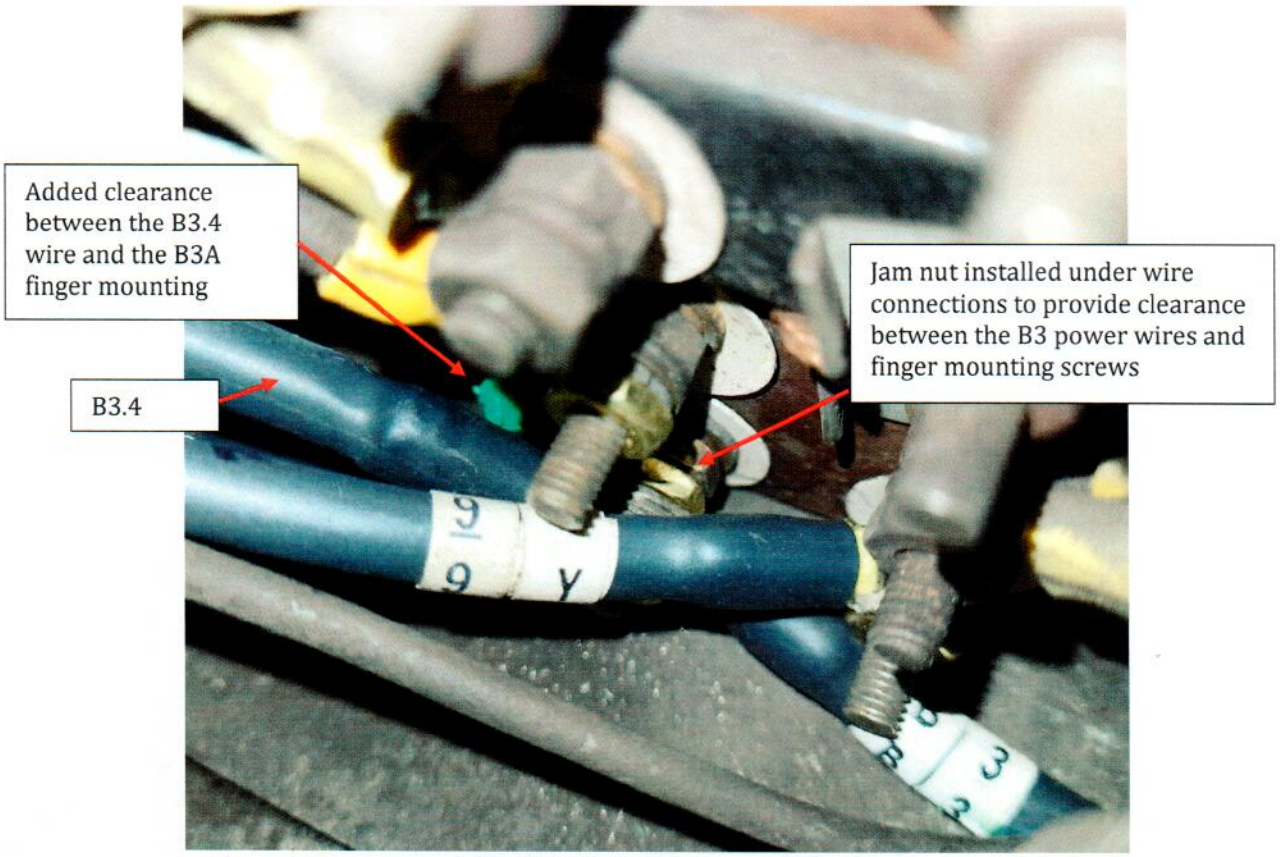


Figure 4: Cineston Controller left side terminal wiring – Jam nut installed to create clearance

10.0 Prepared By

PII [redacted]

Scott Manning
Engineer
Red Line Engineering

4/21/22
Date

12.0 Approval

PII [redacted]

Pat McQuiggan
Superintendent
Red Line Maintenance

4/21/22
Date

PII [redacted]

Jay Berry
Deputy Director
Heavy Rail Maintenance

4/21/22
Date

PII [redacted]

Mike Walsh
Maintenance Director
Heavy Rail Maintenance

4/21/22
Date

APPENDIX A

Impound Report # 21251

Field notes from testing that was conducted to determine the root cause of the failed interlock on car 1511

Field Notes

Consist: 1511-10-1614-15-1757-56
Impound #: 21251

Day 1 - 4/11/22

1. Carhouse Inspection - Cabot Track 6
   - Present: NTSB, DPU, Transit Police, MBTA Safety Dept, MBTA Engineering, MBTA 589 delegates, MBTA Management, MBTA Inspectors, and MBTA repairers.
   - Train Configuration: 1511-10-1614-15-1757-56
   - Initial Visual Inspection
     - Interior Motorman Cabs and Passenger Compartment starting at end car 1756
       - All sealed switches were in the normal state
       - The door bypass and no motion bypass switches were all in the normal state
       - The main battery breakers on each car were turned-off
         - The car was in the carhouse so this was done to prevent batteries from draining.
       - All system control breakers (37 VDC) were in the on position
       - All passenger doors were found undamaged
2. Carhouse Testing 1 – Cabot Track 6
   - Present: NTSB, DPU, Transit Police, MBTA Safety Dept, MBTA Engineering, MBTA 589 delegates, MBTA Management, MBTA Inspectors, and MBTA repairers.
   - Train Configuration: 1511-10-1614-15-1757-56
   - Test 1: Recycle Testing – Car # 1510
     - Steps
       - The E doors were recycle tested at the 3 standard locations approved by the DPU: 6 inches from the top, the middle, and 6 inches from the bottom
     - Results
       - Both doors passed at each location
   - Test 2: Propulsion Interlock Testing – Car # 1511
     - Steps
       - The doors were opened and closed via the door operator switch on 1511
       - An obstruction was placed in the path of the E1 door to repeatedly recycle the door
       - The train driven from car 1511 was placed into 1st notch power
     - Results
       - The signal light was “on” indicating that E1 did not close and lock
       - The door interlock did not pick indicating an open door
       - The consist was able to take power (move) with the door open
     - Test Notes
       - The interlock on car 1511 did not cut the voltage from the propulsion trains lines allowing the train to take power with the doors open
3. Track Testing 1 – Cabot Yard Test Track
   - Present: NTSB, DPU, Transit Police, MBTA Safety Dept, MBTA Engineering, MBTA 589 delegates, MBTA Management, MBTA Inspectors, and MBTA repairers.
   - Train Configuration: 1511-10-1614-15-1757-56

Field Notes

Consist: 1511-10-1614-15-1757-56
Impound #: 21251

- Test 1: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was in the “normal” position
    - The doors on the motorman side of the lead car 1511 were opened
    - The lead car 1511 was placed in 4th notch power.
  - Results
    - The consist moved forward
    - The doors closed shortly after the train began to move ~ 10 ft
- Test 2: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was in the “normal” position
    - The doors on both sides of the train were opened
    - The lead car 1511 was placed in 4th notch power
  - Results
    - The consist moved forward
    - The doors closed shortly after the train began to move ~ 10 ft
- Test 3: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was in the “bypass” position
    - The doors on both sides of the train were opened
    - The lead car 1511 was placed in 4th notch power
  - Results
    - The consist moved forward
    - The doors closed shortly after the train began to move ~ 10 ft
- Test 4: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was in the “normal” position
    - The doors on the motorman side of the lead car 1511 were opened and then closed
    - The 7/8” test dowel was placed in the path of the E2 door on car 1510 approximately midway between top and bottom to keep the door recycling.
    - The lead car 1511 was placed in 4th notch power
  - Results
    - The consist moved forward
    - The E2 doors stopped recycling on the dowel shortly after the train began to move (~ 10 ft) and started again when the train was almost stopped
- Test 5: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was in the “normal” position
    - The doors on the motorman side of the lead car 1511 were opened and then closed

        - A fire extinguisher was placed in the path of the E2 door of car 1510 approximately midway between top and bottom to keep the door recycling.
        - The lead car 1511 was placed in 4th notch power
    - Results
        - The consist moved forward
        - The E2 doors stopped recycling on the fire extinguisher shortly after the train began to move (~ 10 ft) and started again when the train was almost stopped
- Test Notes:
    - The door interlock on car 1511 was not operating properly and would take power with a door open
    - The no motion system deactivates the door obstruction system at speeds over approximately 2 to 3 mph.

4. Carhouse Testing 2 – Cabot 6 Track

- Present: NTSB, DPU, MBTA Engineering, and an MBTA repairer
- Train Configuration: 1511-10-1614-15-1757-56
- Test 1: Propulsion Interlock Testing
    - Steps
        - The E1 door was left open and the lead car 1511 was placed in 1st power (The E2 had been repeatedly tested prior)
    - Results
        - The train moved forward
- Test 2: Propulsion Interlock Testing
    - Steps
        - The guard side doors (relative to car 1511) were left open and the lead car 1511 was placed in 1st power (motorman side side doors were tested earlier)
    - Results
        - The train moved forward.
- Test 3: Propulsion Interlock Testing
    - Steps
        - The door bypass switch on the lead car 1511 was placed into “bypass”
        - The guard side doors (relative to car 1511) were left open and the lead car 1511 was placed in 1st power (motorman side doors were tested earlier)
    - Results
        - The train moved forward.
- Test 4: Propulsion Interlock Testing
    - Steps
        - The motorman side doors (relative to car 1511) on cars 1510 and 1511 were opened from car 1614
        - Lead car 1614 was placed into 1st power.
    - Results
        - The train moved forward

Field Notes

Consist: 1511-10-1614-15-1757-56
Impound #: 21251

- Test 5: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on cars 1510, 1511, 1615, and 1614 were opened from car 1615
    - Lead car 1615 was placed into 1st power.
  - Results
    - The train moved forward
- Test 6: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1757 (doors forward and rear of car 1757)
    - Lead car 1757 was placed into 1st power.
  - Results
    - The train did not move
- Test 7: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1756 (end car)
    - Lead car 1756 was placed into 1st power.
  - Results
    - The train did not move (the interlock operated properly)
- Test 8: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1614 (doors forward and rear of car 1614)
    - Lead car 1614 was placed into 1st power.
  - Results
    - The train did not move
- Test 9: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1615 (doors forward and rear of car 1615)
    - Lead car 1615 was placed into 1st power.
  - Results
    - The train did not move
- Test 10: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1510 (doors forward and rear of car 1510)
    - Lead car 1510 was placed into 1st power.

- Results
  - The train did not move
- Test 11: Propulsion Interlock Testing
  - Steps
    - The motorman side doors (relative to car 1511) on all cars were opened from car 1511 (end car).
    - Lead car 1511 was placed into 1st power.
  - Results
    - The train moved forward
- Test Notes:
  - When powered from a middle car, the interlock coil will receive voltage signals from both ends of the consist. The interlock only needs one signal to energize so if one signal is missing due to an open door it will still be energized by the other.
  - The door interlock on the end car 1756 worked properly and did not take power with doors open.

5. Carhouse Testing 3 – Cabot 6 Track

- Present: NTSB, DPU, MBTA Engineering, and an MBTA repairer
- Train Configurations: 1756-57; 1615-14-1510-11; 1614-15; 1510-11
- Note: Began separating cars to isolate issue
- Test 1: Propulsion Interlock Testing
  - Steps
    - Cars 1756-57 were separated from the consist
    - The motorman side doors (relative to car 1757) were opened from car 1757
    - Lead car 1757 was placed into 1st power.
  - Results
    - The train did not move
- Test 2: Propulsion Interlock Testing
  - Steps
    - Cars 1756-57 remained separated from the consist
    - The guard side doors (relative to car 1757) were opened from car 1757
    - Lead car 1757 was placed into 1st power.
  - Results
    - The train did not move
- Test 3: Propulsion Interlock Testing
  - Steps
    - Cars 1615-14-1510-1511 were tested as a four car consist
    - The motorman side doors (relative to car 1511) were opened from car 1511
    - Lead car 1511 was placed into 1st power.
  - Results
    - The train moved forward
- Test 4: Propulsion Interlock Testing

    - Steps
        - Cars 1615-14-1510-1511 were tested as a four car consist
        - The guard side doors (relative to car 1511) were opened from car 1511
        - Lead car 1511 was placed into 1st power.
    - Results
        - The train moved forward
- Test 5: Propulsion Interlock Testing
    - Steps
        - Cars 1614-15 were separated from cars 1510-11
        - The motorman side doors (relative to car 1614) were opened from car 1614
        - Lead car 1614 was placed into 1st power.
    - Results
        - The train did not move
- Test 6: Propulsion Interlock Testing
    - Steps
        - Cars 1614-15 remained separated from all other cars
        - The guard side doors (relative to car 1614) were opened from car 1614
        - Lead car 1614 was placed into 1st power.
    - Results
        - The train did not move
- Test 7: Propulsion Interlock Testing
    - Steps
        - Cars 1614-15 remained separated from all other cars
        - The motorman side doors (relative to car 1615) were opened from car 1615
        - Lead car 1615 was placed into 1st power.
    - Results
        - The train did not move
- Test 8: Propulsion Interlock Testing
    - Steps
        - Cars 1614-15 remained separated from all other cars
        - The guard side doors (relative to car 1615) were opened from car 1615
        - Lead car 1615 was placed into 1st power.
    - Results
        - The train did not move
- Test 9: Propulsion Interlock Testing
    - Steps
        - Cars 1510-11 were tested alone
        - The motorman side doors (relative to car 1511) were opened from car 1511
        - Lead car 1511 was placed into 1st power.
    - Results
        - The train moved forward
    - Test 10: Propulsion Interlock Testing

    - Steps
        - Cars 1510-11 were tested alone
        - The guard side doors (relative to car 1511) were opened from car 1511
        - Lead car 1511 was placed into 1st power.
    - Results
        - The train moved forward
- Test 11: Propulsion Interlock Testing
    - Steps
        - Cars 1510-11 were tested alone
        - The motorman side doors (relative to car 1510) were opened from car 1510
        - Lead car 1510 was placed into 1st power.
    - Results
        - The train did not move
- Test 12: Propulsion Interlock Testing
    - Steps
        - Cars 1510-11 were tested alone
        - The guard side doors (relative to car 1510) were opened from car 1510
        - Lead car 1510 was placed into 1st power.
    - Results
        - The train did not move
- Test Notes:
    - It was determined that the door interlock on car 1511 was not functioning properly.

Day 2 – 4/12/21

6. Troubleshooting/ Repair

- NTSB, DPU, MBTA Engineering, and an MBTA repairer present
- Steps
    - Methodically inspected connections and measured voltages at each point of the interlock circuit on car 1511
- Results/ Notes
    - Found voltage applied to the Cineston propulsion fingers whether the door interlock contacts were open or closed.
    - The voltage appeared to be coming from a power source located at the Cineston
    - The B3 breaker supplies power to the propulsion power and braking trainlines so the four B3 wires and connections were inspected
    - The B3.4 wire attached to the B3 contact stud of the Cineston left terminal block was found chafed and shorted to the B3A finger mounting screw. The mounting screw is not insolated from the finger contacts.
    - The B3A finger contacts connect interlock controlled power to the propulsion trainlines via Cineston cams.

    - The shorted B3.4 wire essentially jumped the door interlock contacts providing power for the Cineston fingers to apply to the propulsion train lines regardless of passenger door position.
- Repair
    - The B3.4 was pulled away from the B3A finger mounting screw which removed the electrical short (A permanent solution is TBD).

7. Carhouse Testing 3 – Cabot 6 Track

- NTSB, DPU, MBTA Engineering, and an MBTA repairer present
- Test 1: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist were left open and the lead car 1511 was placed in 1st power
    - Results
        - The train did not move
- Test 2: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist were left closed and the lead car 1511 was placed in 1st power
    - Results
        - The consist moved forward
- Test 3: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1510) were left open and the lead car 1510 was placed in 1st power
    - Results
        - The consist did not move
- Test 4: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1510) were closed and the lead car 1510 was placed in 1st power
    - Results
        - The consist moved forward
- Test 5: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1614) were left open and the lead car 1614 was placed in 1st power
    - Results
        - The consist did not move
- Test 6: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1615) were left open and the lead car 1615 was placed in 1st power

Field Notes

Consist: 1511-10-1614-15-1757-56
Impound #: 21251

    - Results
        - The consist did not move
- Test 7: Propulsion Interlock Testing
    - Steps
        - The doors on cars 1614, 1615, 1510 and 1511 were left open while the rest remained closed.
        - The lead car 1614 was placed in 1st power
    - Results
        - The consist moved forward
- Test 8: Propulsion Interlock Testing
    - Steps
        - The doors on cars 1757, and 1756 were left open while the rest remained closed.
        - The lead car 1614 was placed in 1st power
    - Results
        - The consist moved forward
- Test 9: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1757) were left open and the lead car 1757 was placed in 1st power
    - Results
        - The consist did not move
- Test 10: Propulsion Interlock Testing
    - Steps
        - The doors on both sides of the consist (forward and rear of 1757) were closed and the lead car 1757 was placed in 1st power
    - Results
        - The consist moved forward
- Test 11: Propulsion Interlock Testing
    - Steps
        - The doors both sides of the consist were left open and the lead car 1756 (end car) was placed in 1st power
    - Results
        - The consist did not move
- Test 12: Propulsion Interlock Testing
    - Steps
        - The doors on the consist were closed and the lead car 1756 was placed in 1st power
    - Results
        - The consist moved forward
- Test Notes
    - The door interlock systems on both end cars 1511 and 1756 functioned properly.

- The door interlock was not designed to operate from a middle car and will allow the consist to move with a door open.

8. Track Testing 2 – Cabot Yard Test Track

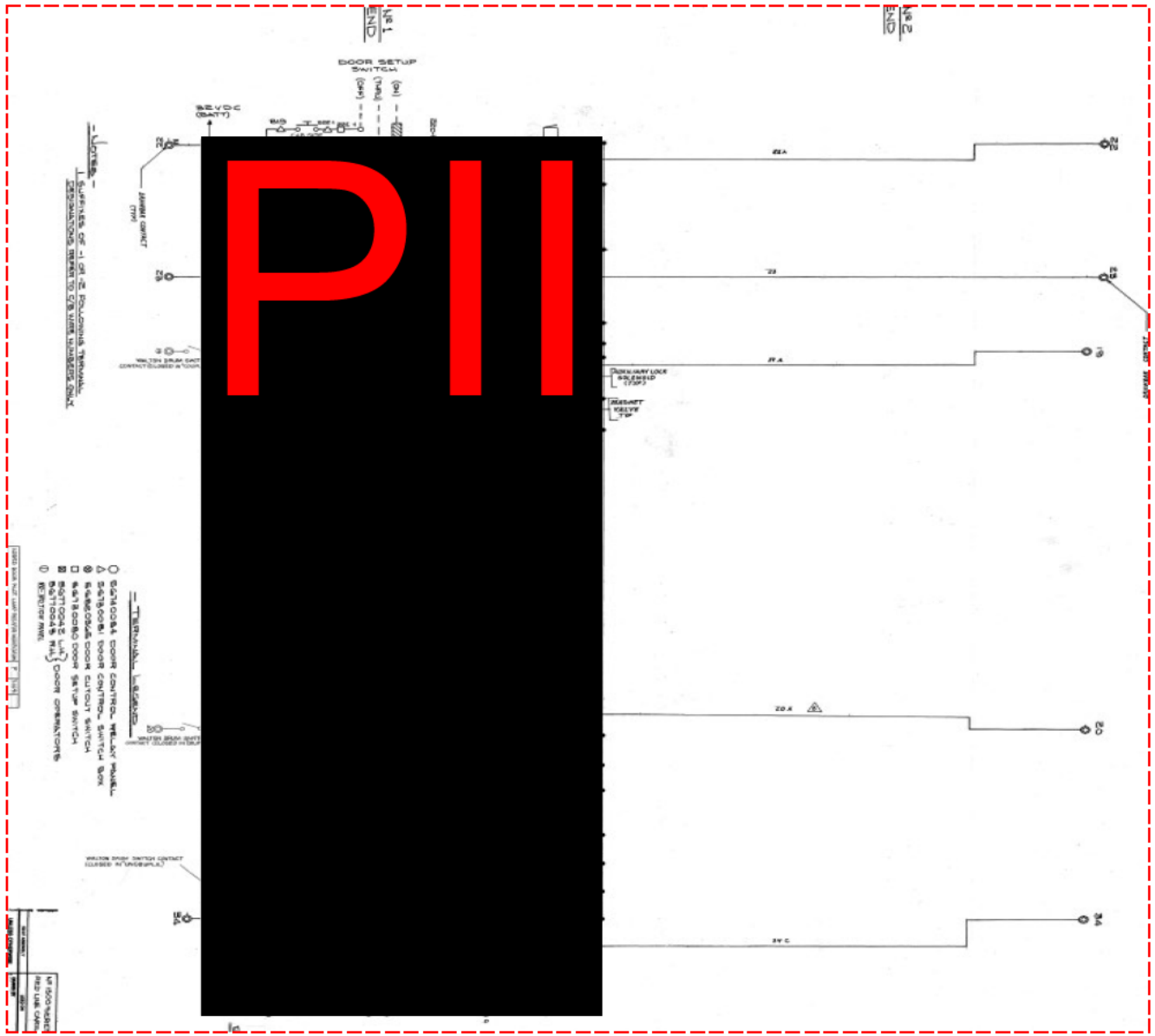
- NTSB, DPU, Transit Police, MBTA Safety Dept, MBTA Engineering, MBTA 589 delegates, MBTA Management, MBTA Inspectors, and MBTA repairers present
- Test 1: Propulsion Interlock Testing
  - Steps
    - The doors on motorman side of the consist (relative to car 1511) were left open and the lead car 1511 was placed in 1st power
  - Results
    - The consist did not move
    - The pilot lights remained lit
    - The door audible signals worked properly (did not ring)
- Test 2: Propulsion Interlock Testing
  - Steps
    - The doors on guard side of the consist (relative to car 1511) were left open and the lead car 1511 was placed in 1st power
  - Results
    - The train did not move
    - The pilot lights remained lit
    - The door audible signals worked properly (did not ring)
- Test 3: Propulsion Interlock Testing
  - Steps
    - The doors on motorman side of the consist (relative to car 1511) were left open and the lead car 1756 was placed in 1st power
  - Results
    - The consist did not move
    - The pilot lights remained lit
    - The door audible signals worked properly (did not ring)
- Test 4: Propulsion Interlock Testing
  - Steps
    - The doors on guard side of the consist (relative to car 1511) were left open and the lead car 1756 was placed in 1st power
  - Results
    - The consist did not move
    - The pilot lights remained lit
    - The door audible signals worked properly (did not ring)
- Test 5: Propulsion Interlock Testing
  - Steps
    - The door bypass switch was placed into the “normal” position
    - The doors on the motorman side of consist (relative to car 1511) were opened and then closed

        - The 7/8" test dowel was placed in the path of E2 door on car 1510 approximately midway between top and bottom to keep the door recycling.
        - The lead car 1511 was placed in 4th notch power
    - Results
        - The consist did not move
        - The pilot lights remained lit
        - The door audible signals worked properly (did not ring)
- Test 6: Propulsion Interlock Testing
    - Steps
        - The door bypass switch was in the "normal" position
        - The doors on the motorman side of the consist (relative to car 1511 were opened and then closed
        - A fire extinguisher was placed in the path of E2 door of car 1510 approximately midway between top and bottom to keep the door recycling.
        - The lead car 1511 was placed in 4th notch power
    - Results
        - The consist did not move
        - The pilot lights remained lit
        - The door audible signals worked properly (did not ring)
- Test 7: Propulsion Interlock Testing
    - Steps
        - The door bypass switch was in the "bypass" position
        - The doors on the motorman side of the lead car 1511 were opened and then closed
        - A fire extinguisher was placed in the path of E2 door of car 1510 approximately midway between top and bottom to keep the door recycling.
        - The lead car 1511 was placed in 4th notch power
    - Results
        - The consist moved forward
        - The E2 doors stopped recycling on the fire extinguisher shortly after the train began to move (~ 10 ft) and started again when the train was almost stopped
        - The pilot lights remained lit
        - The door audible signals worked properly (did not ring)
- Test Notes
    - The door interlock system on cars 1511 and 1756 worked properly.
    - The door signal system on each car worked properly
    - The no motion system deactivates the door obstruction system recycling over approximately 2 to 3 mph.

APPENDIX B

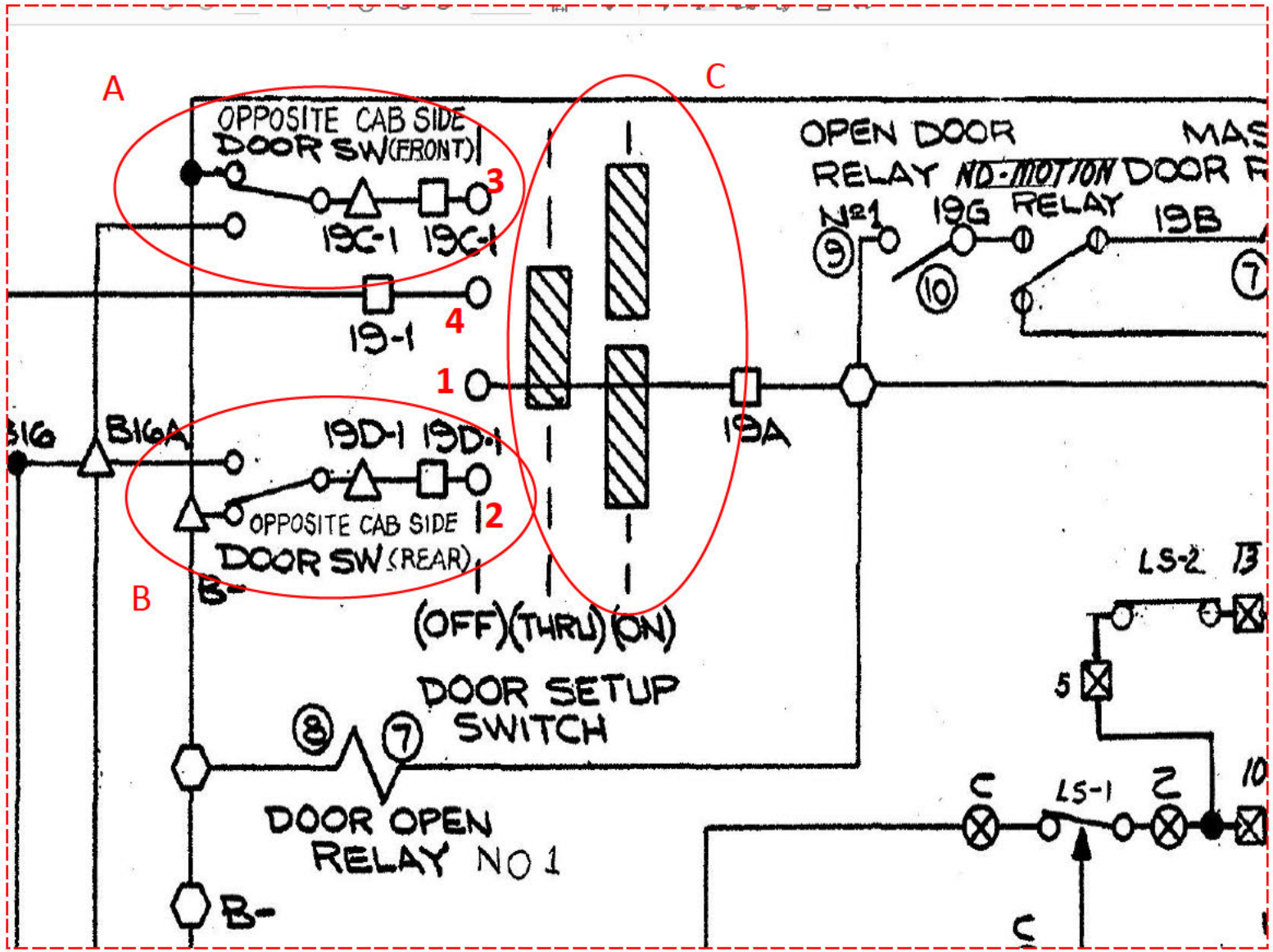
Impound Report # 21251

Step by step explanation of the Door Interlock Circuit on the 1500 series trains



The Circuit to the Left is the Red Line ##1 Door Control Circuit

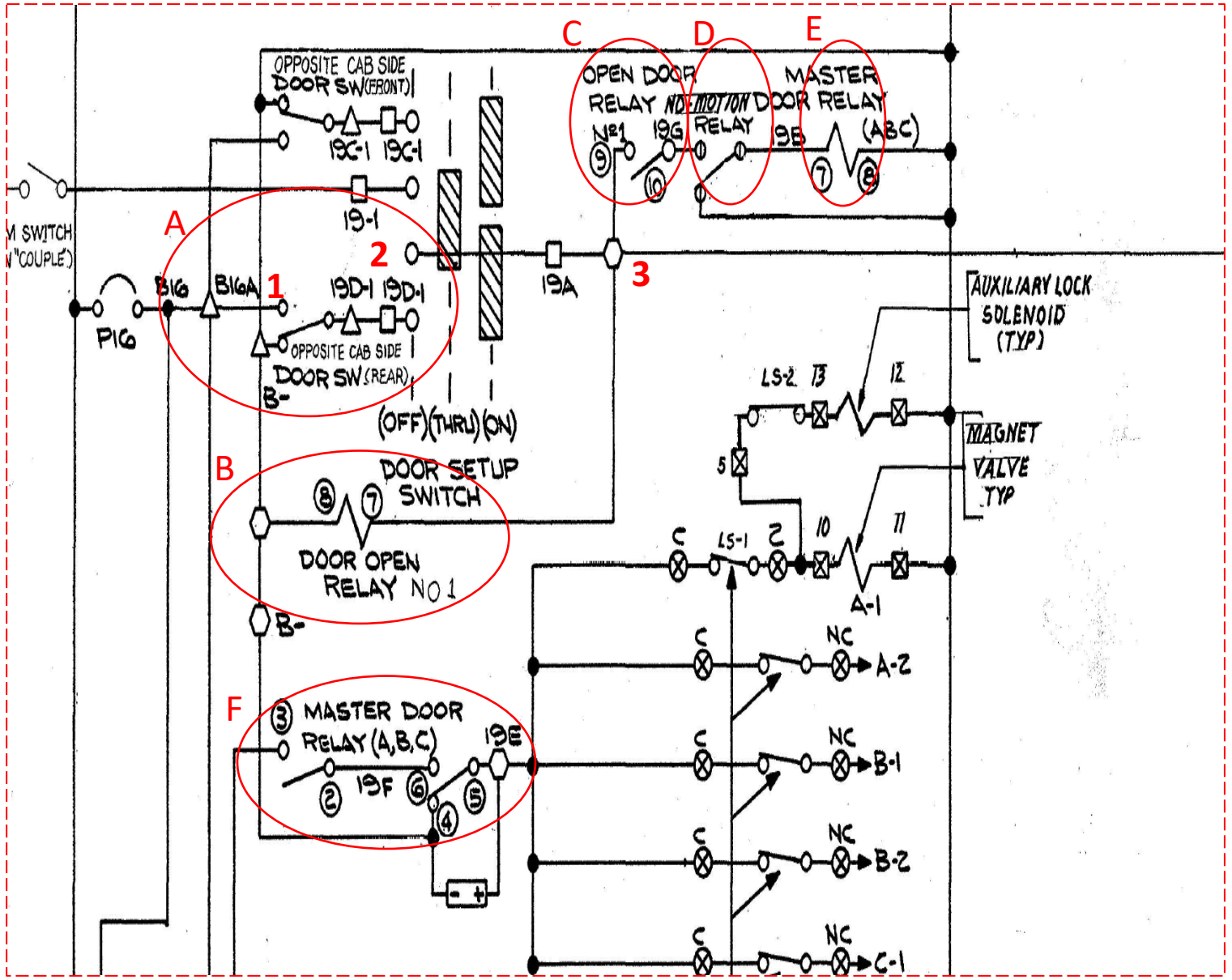
We will go through the Sequence of Door Operation for the Electronics first



A – Door Operator Switch Forward. Switch is shown in the Closed Position

B – Door Operator Switch Rear Doors. Switch is shown in the Closed Position

C – Door Setup Switch. When Setup switch is in the “ON” Position Pins 1 and 2 are connected and Pins 3 and 4 are connected. This gives the Operator control of the Doors from the Cab



A – Operator turns Door Operator Switch to Open

Pin 1 (37VDC) is connected to Pin 2 through the Door Setup Switch

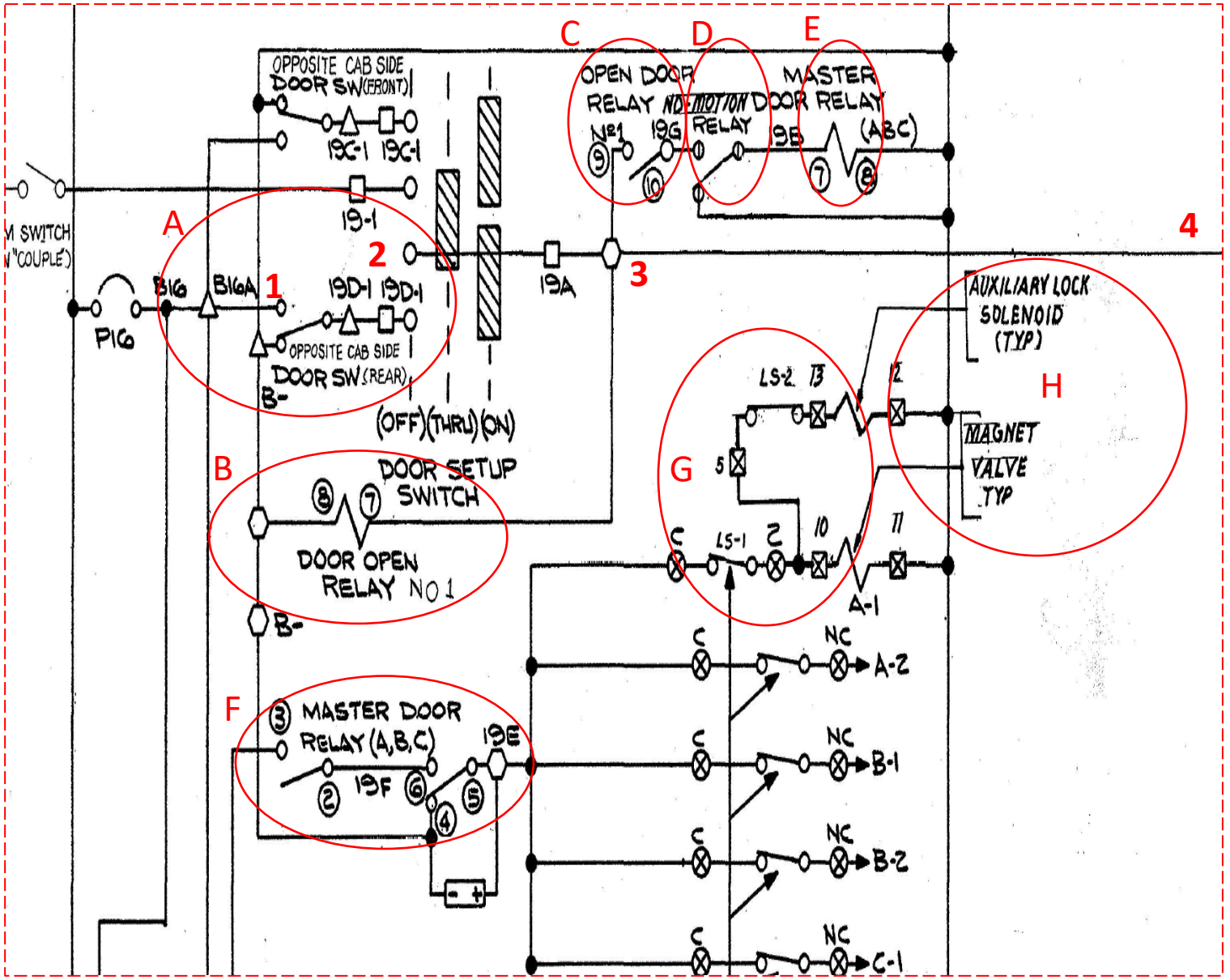
B – 37VDC is applied to Junction Point 3 which activates the Door Open Relay

C – After Door Open Relay is activated the Contacts close

D – If the Train is at No Motion (Less than 3 MPH) the No Motion Relay is activated and these contacts Close

E – Master Relay is now Activated

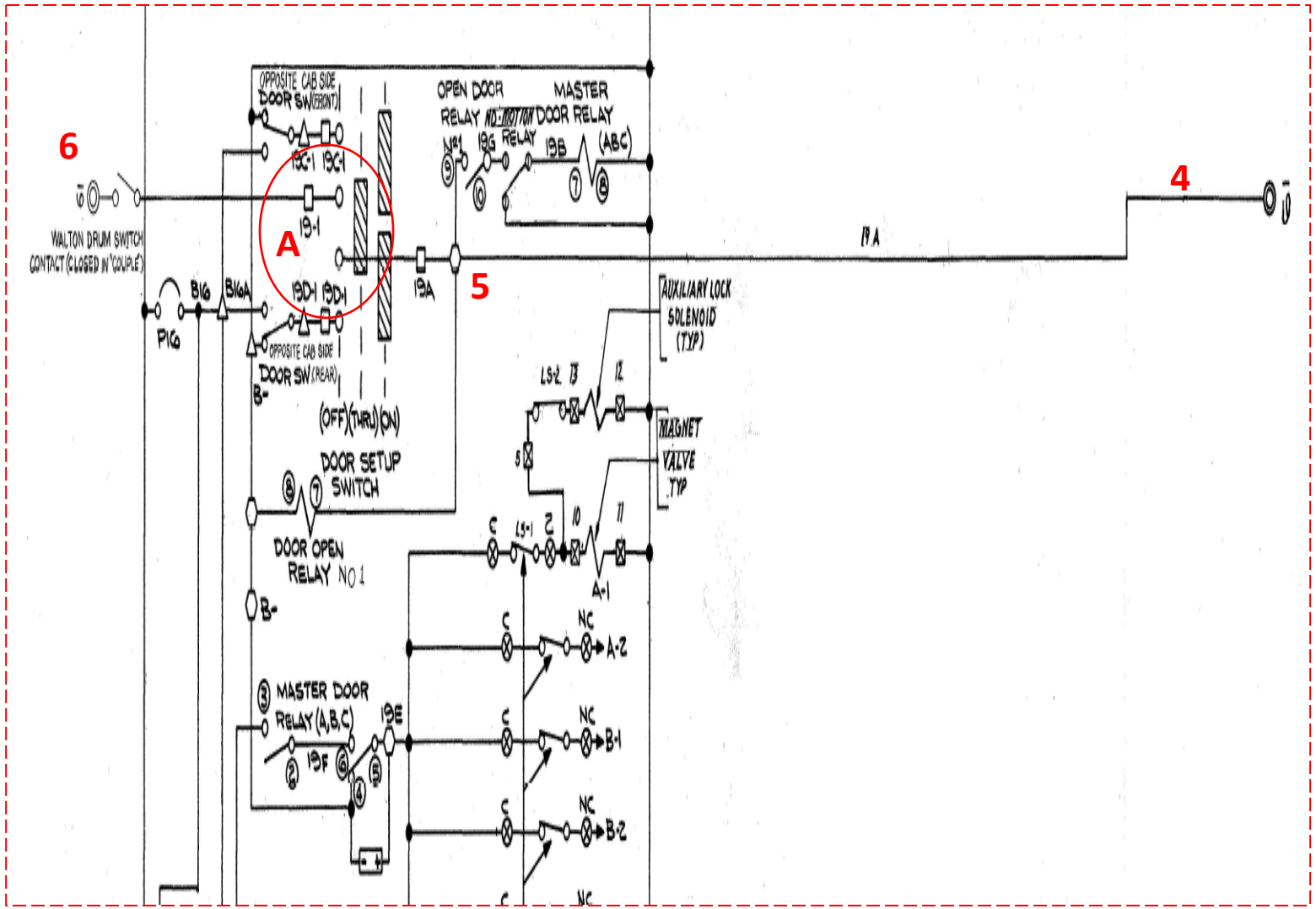
F – Master Relay Contacts are Closed



G – 37VDC is applied to each LS1 and LS2 Switches on each Door Engine. The Operation of these Switches will be explained on the Door Obstruction Section of this explanation

H – The 37VDC is then added to the Auxiliary Lock Solenoid and the Magnet Valve which causes the Doors to Open

4 – This is the Train Line Door Open Signal from Lead Car to Next Car. This will be explained on next Slide



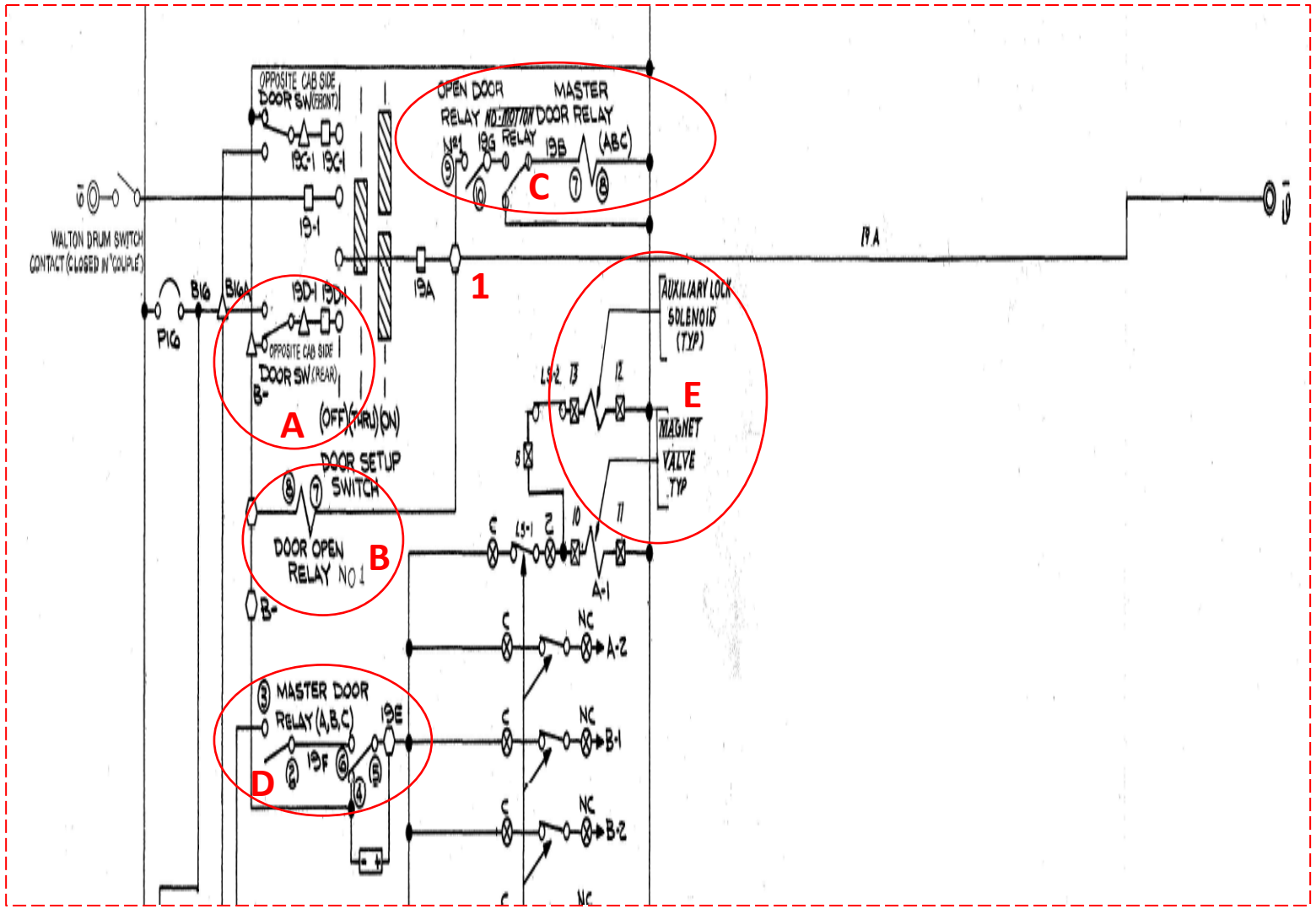
4 – Door Open Signal from Lead Car through #2 End Jumper to Second Car

5 – Door Open Signal to Second car of Married Pair which activates Door Open Relay and follows same opening sequence as Lead Car

A – Door Setup Switch is on “THRU” and this applies Signal to Point 6

6 – Door Open Signal is sent thru the Coupler to Second Married Pair

Sequence follows for whole Consist until Last Car which has Door Setup Switch in the “OFF” Position so no signal is sent to the Coupler



A – Door Operator Switch is moved to Close Position. This ties the Signal to Ground.

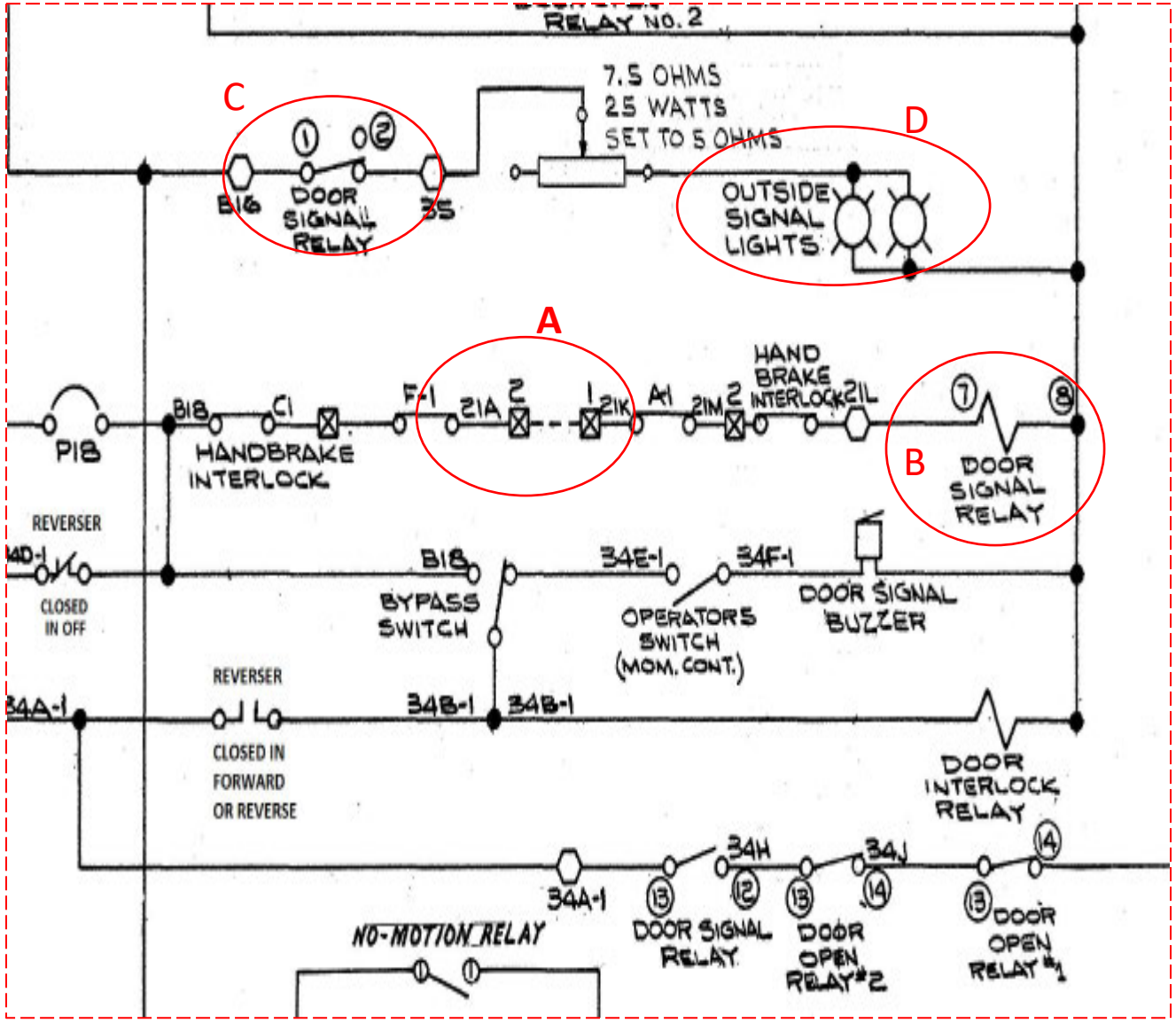
1 – Voltage at this Point is now Ground

B – Door Open Relay drops out

C – Door Open Relay Contact drops out shutting of the Master Door Relay

D – Master Door Relay Contacts open

E – Auxiliary Lock Solenoid and Magnet Valve drop out causing Doors Engines to Close.



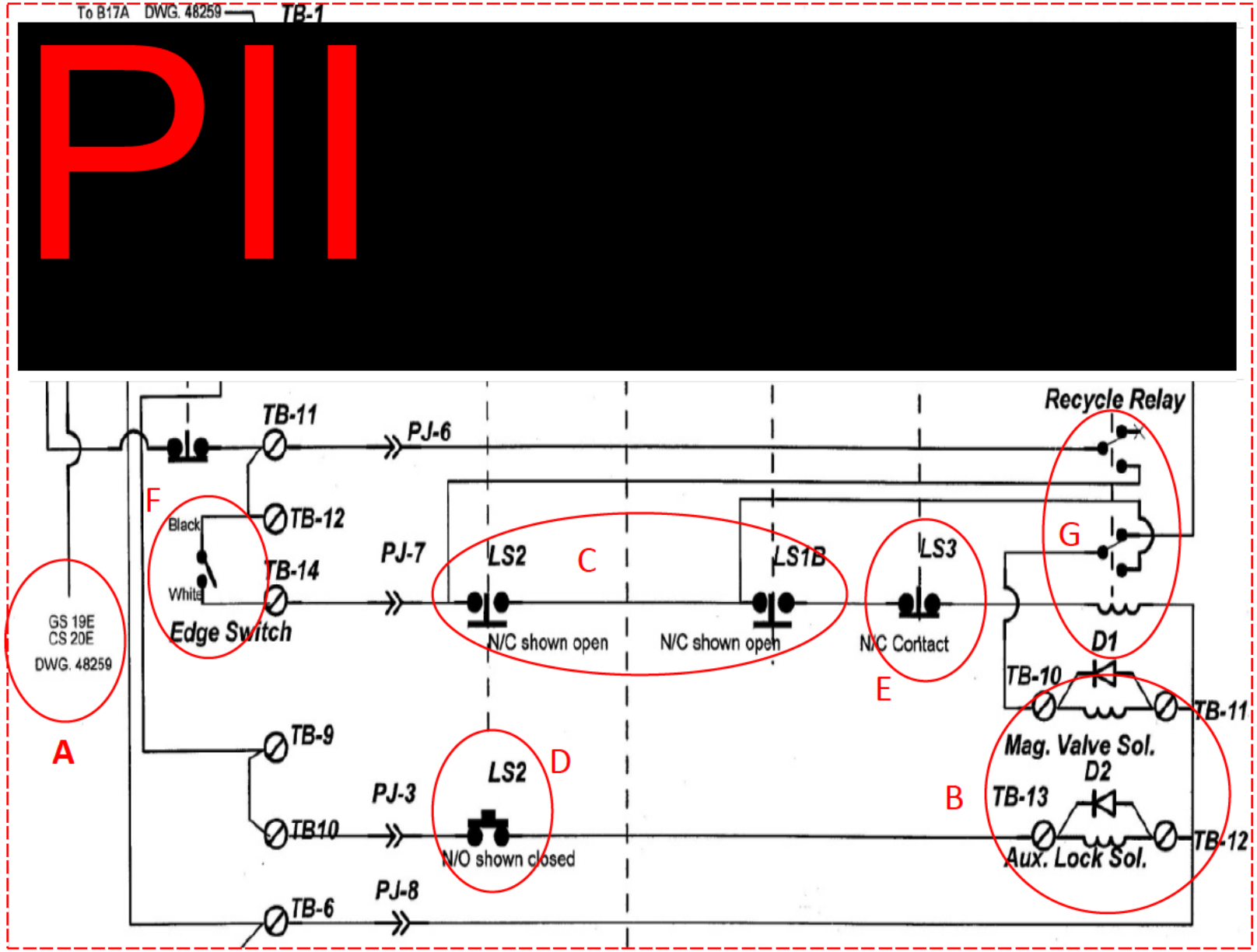
A – All Door LS1 Switches have Closed, indicating the Door Locking Pawl has Dropped and Locked the Door Closed

B – Door Signal Relay activates

C – Door Signal Relay Contact opens (Position 2)

D – Outside Signal Lights (Pilot Lights) extinguish to indicate to Operator all Doors are Closed and Locked

PII



A – Door Open Signal from Operator's Cab

B – Magnet Valve Solenoid and Auxiliary Lock Solenoid Active opening Doors

C – LS2 and LS1B and LS3 Close

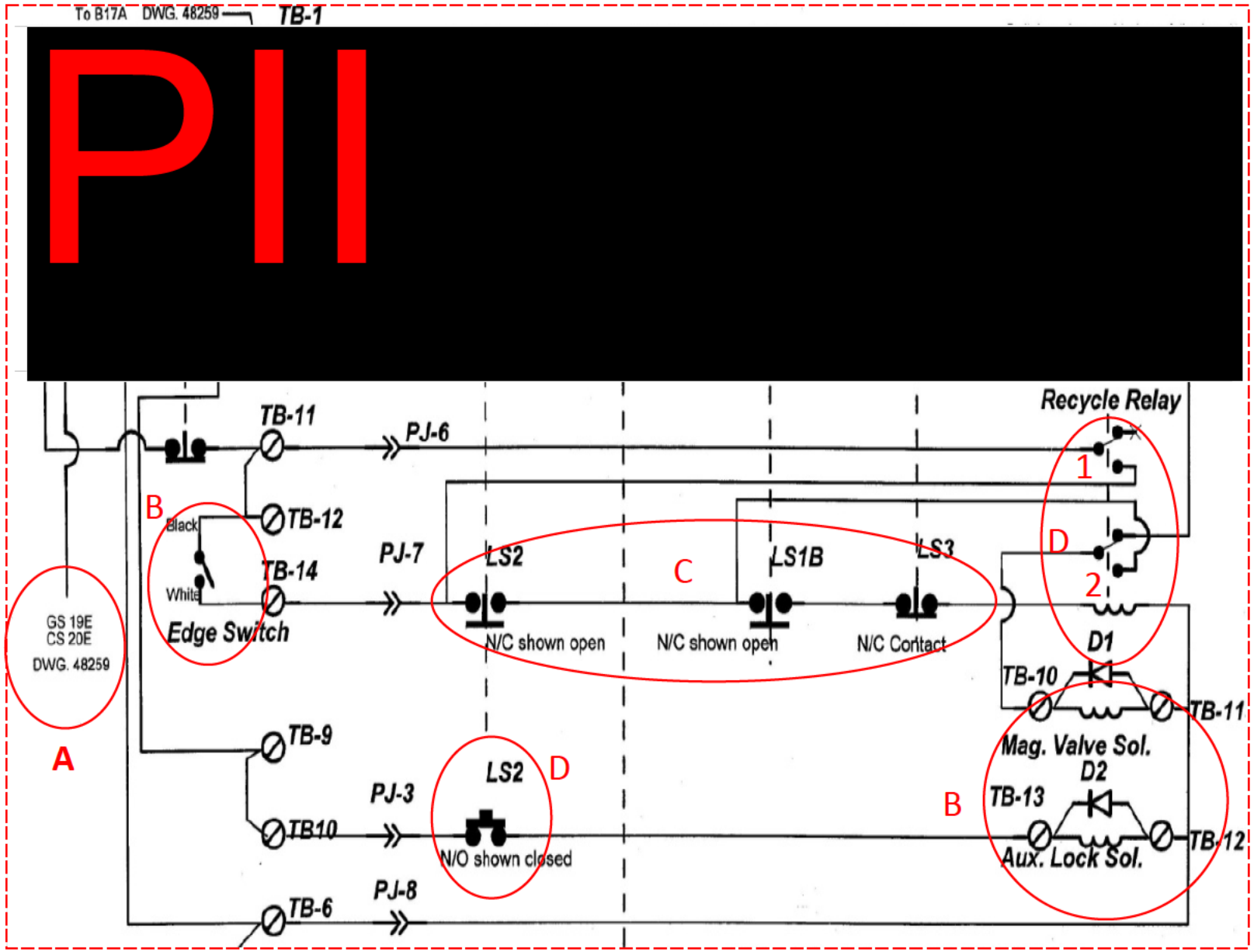
D – LS2 Opens when Door opens

E – LS3 is Open when Doors are fully open. When doors start to Close LS3 is closed activating the Sensitive Edge

F – Sensitive Edge Switch is supplied power from 37VDC Supply

G – Door Obstruction Relay

LS2 and LS1B now bring Door Obstruction into Circuit



A – Door Close Signal tying this point to Ground

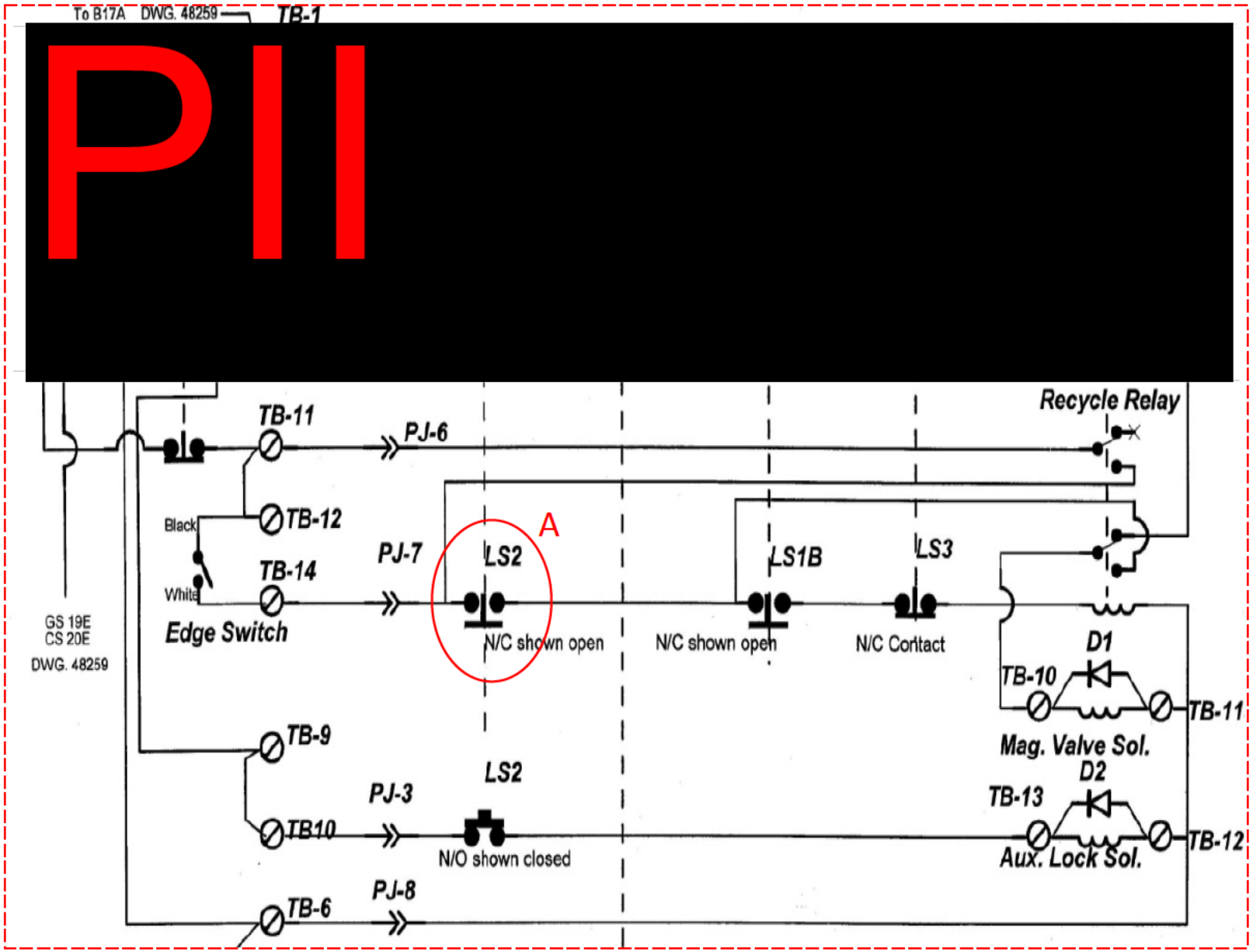
B – Sensitive Edge is activated

C – Sensitive Edge applies 37VDC through LS2, LS1B and LS3 to activate D1 Sensitive Edge Relay

D – Sensitive Edge Relay Activates closing Contacts

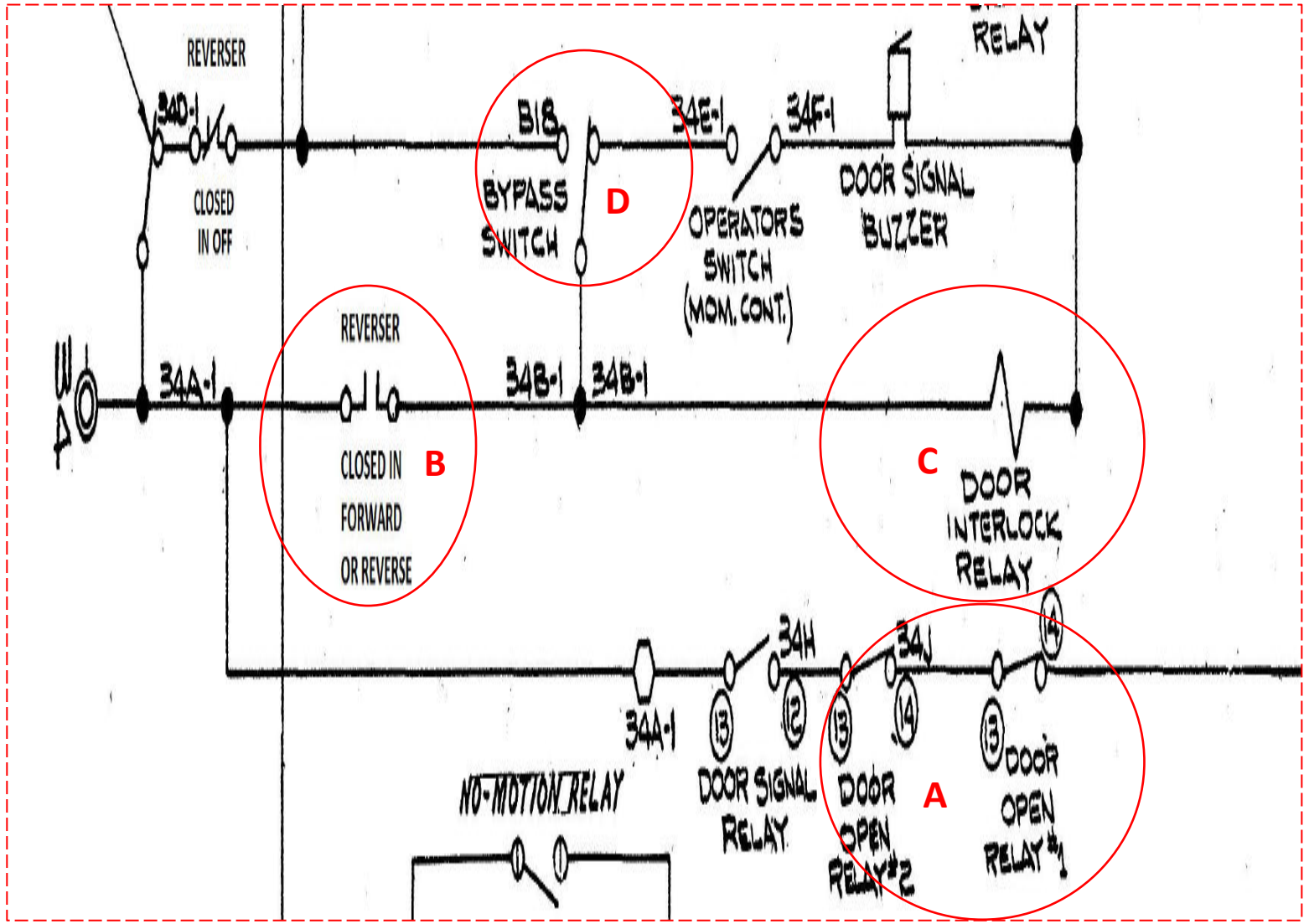
1 – Top Contact closes latching the Sensitive Edge Relay (D1) until Door Fully Opens and LS3 Drops Out

2 – Bottom Contact closes activating Magnet Valve Solenoid and Auxiliary Lock Solenoid



A – LS2 Switch Opens when doors are near fully Closed

This deactivates the Door Sensitive Edge Relay and removes the Door Obstruction



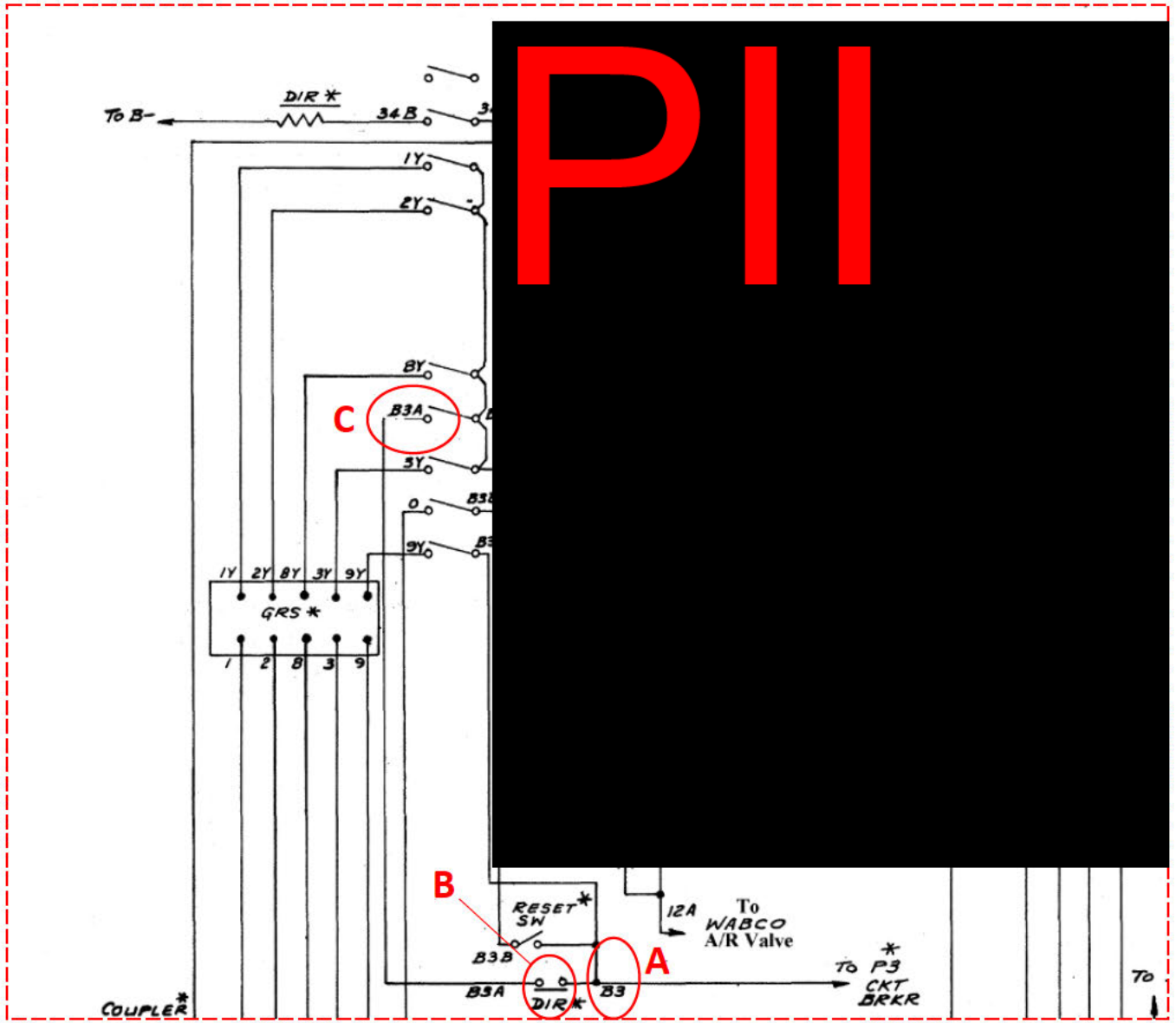
A – When the Doors are in the Open Position the Relay Contacts for Door Open Relay 1 and 2 are Open'

Once the Doors are Closed these Contacts Close providing 37VDC to the Circuit

B – The is the Master Controller (Cinneston) Reverser Switch. If this Switch is on Forward or Reverse, it will allow 37VDC to the Door Interlock Relay

C – The Door Interlock Relay is Activated once all Doors are Closed. This will relay will close the contacts allowing the train to take propulsion (Contacts not Shown)

D – This is the Bypass Switch when activated applies 37VDC directly to the Door Interlock Bypass allowing the Train to take propulsion

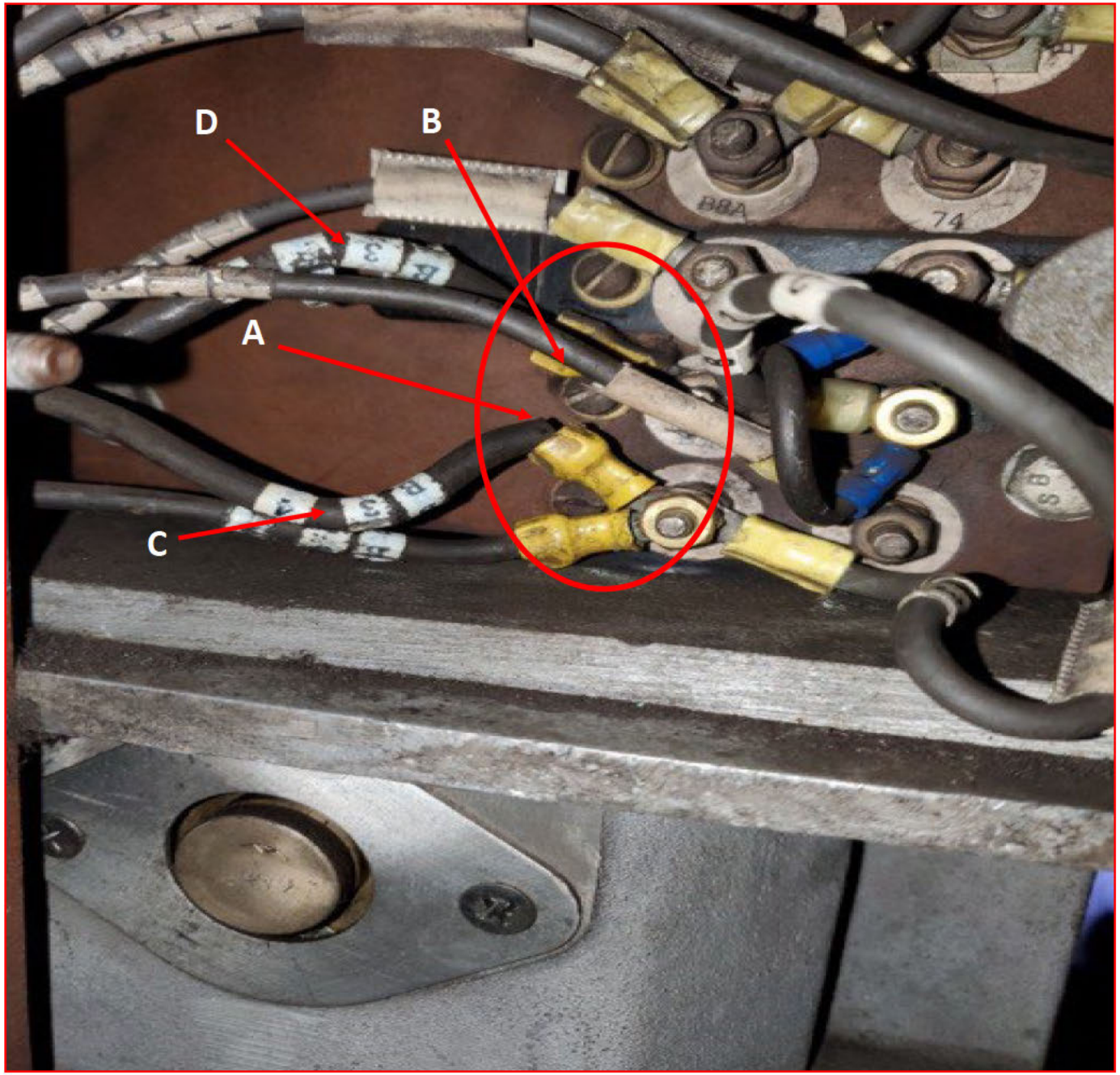


A – This is the 37VDC from the P-3 Circuit Breaker, This voltage is used to provide power through the Cineston to command Propulsion

B – This is the Door Interlock Contact which is Open when the Car Doors are open. This will inhibit Propulsion Power on the Train while the Doors are Open

C – The Point A (B3) Wire Terminal Contact was shorted through a Chafed Wire to Point C (B3A) which Bypassed the Door Interlock Relay Contact (Point B) which allowed the Train to take Propulsion Power with the Doors Open.

This Short Circuit will provide Propulsion Power for all Notches of Power

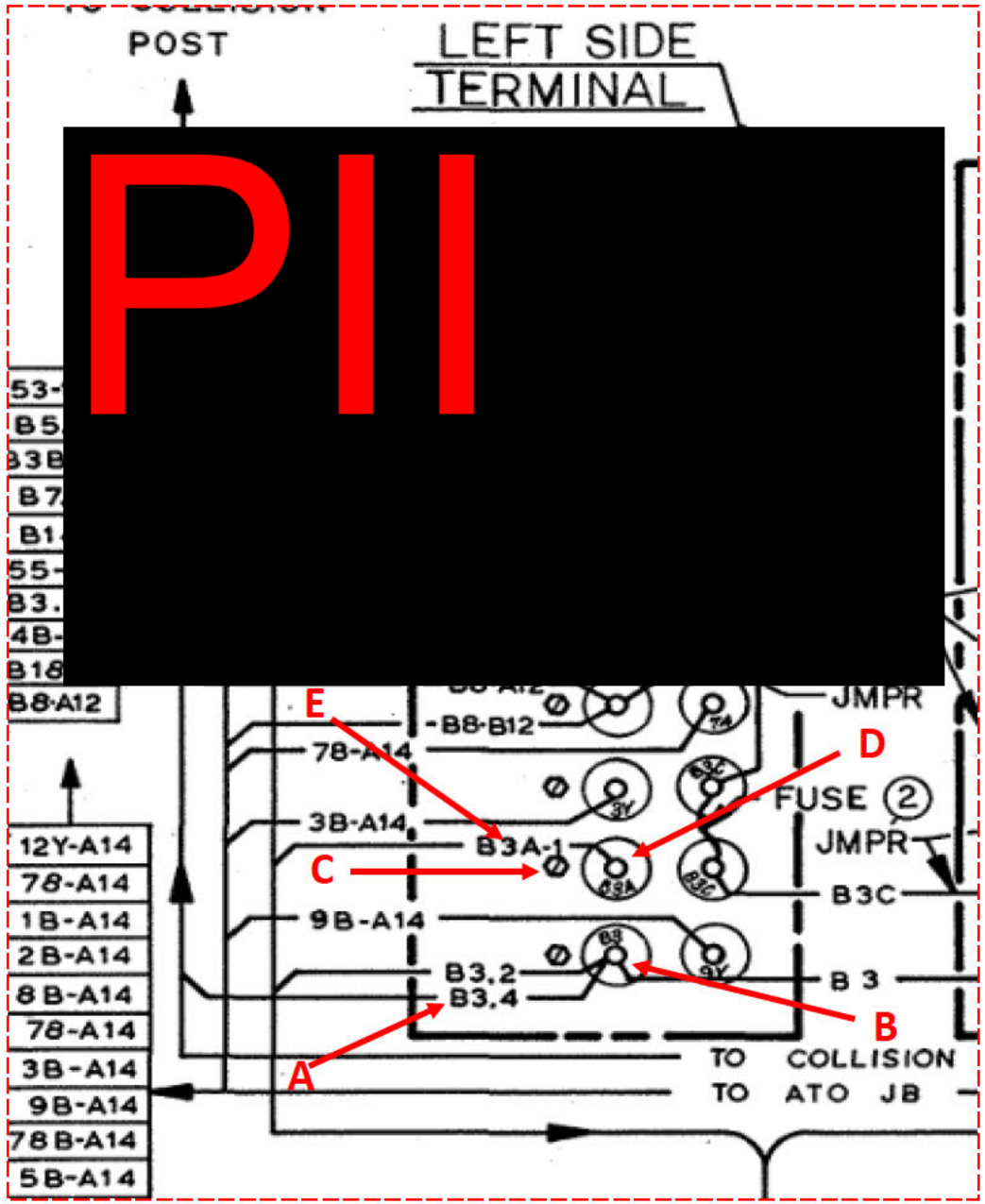


A – This is the shows the wire at the Terminal Connector Insulation Sleeve which showed Chafing and exposed Wire

B – This is the Mounting Screw for the Finger Contactor. This Screw is electrically connected to the Finger Contactor and when the wire B3.4 shorted to the Screw it provided power to B3A

C – This shows the Wire B3.4 Designation from the previous Schematic. Wire B3.4 is just the wire designation for the B3 Wire showing the fourth wire of the wire run

D – This shows the B3A Wire Designation on the Wire that was shorted to Wire B3.4 through the Contact Finger Screw. This is Point C on the previous schematic



A – Point shows the B3.4 Wire on the Cineston Left Side Terminal Block

B – The Wire B3.4 is connected to the Terminal Block Contact Stud B3

C – This is the mounting screw for the Cam Driven Finger Contact. When the Chaffed Wire B3.4 makes contact with this screw it electrically applies power to Cam Driven Finger Contact Body

D – This is Terminal Block Contact Stud B3A on the Cineston Left Side Terminal Block. This is now at 37VDC when B3.4 is shorted to the mounting screw. This jumps out the Door Interlock Relay Contacts allowing the Car 1511 to take power regardless of Door Status

E – The Wire B3A is now at 37VDC and provides propulsion power through the Cineston in all notches.