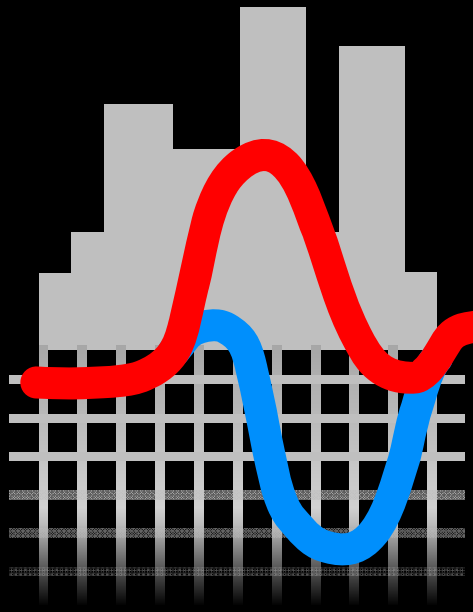


Facility Dynamics
ENGINEERING

Inputs and Outputs – The Field Perspective

Code Issues, Physical Issues, and Terminal Strips

Presented By:

David Sellers; Facility Dynamics Engineering

Senior Engineer

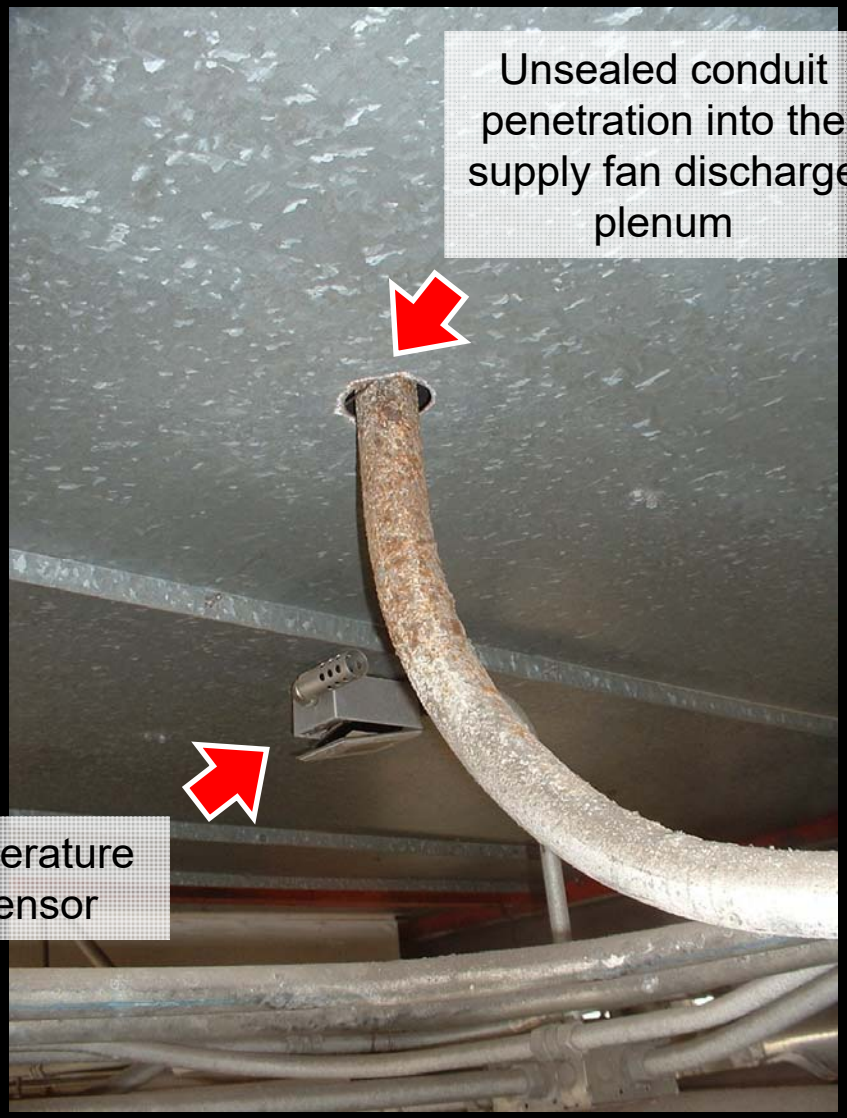
NAVFAC, San Diego

What We Will Cover

- Code issues that impact control systems
- Physical issues that impact control systems
- Specialized terminal strips that can facilitate installation, troubleshooting and persistence

DDC Systems are Electrical Systems

The electrical installation can be critical to the performance of the DDC system



DDC Systems are Electrical Systems

We need to comply with the National Electric Code (NFPA 70)

- Article 100
  - General information
  - Definitions
  - Working space dimensions
- Article 200
  - Terminal identification
  - Grounding conductors

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  - General wiring materials and methods

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  - General wiring materials and methods
- Article 725
  - Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits

DDC Systems are Electrical Systems

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- Article 725
  - Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits

- Article 750
  - Energy Management Systems
  - Prohibits shedding life safety/missiong critical loads
  - Prohibits overloading circuits
  - Basically says “Don’t be stupid”

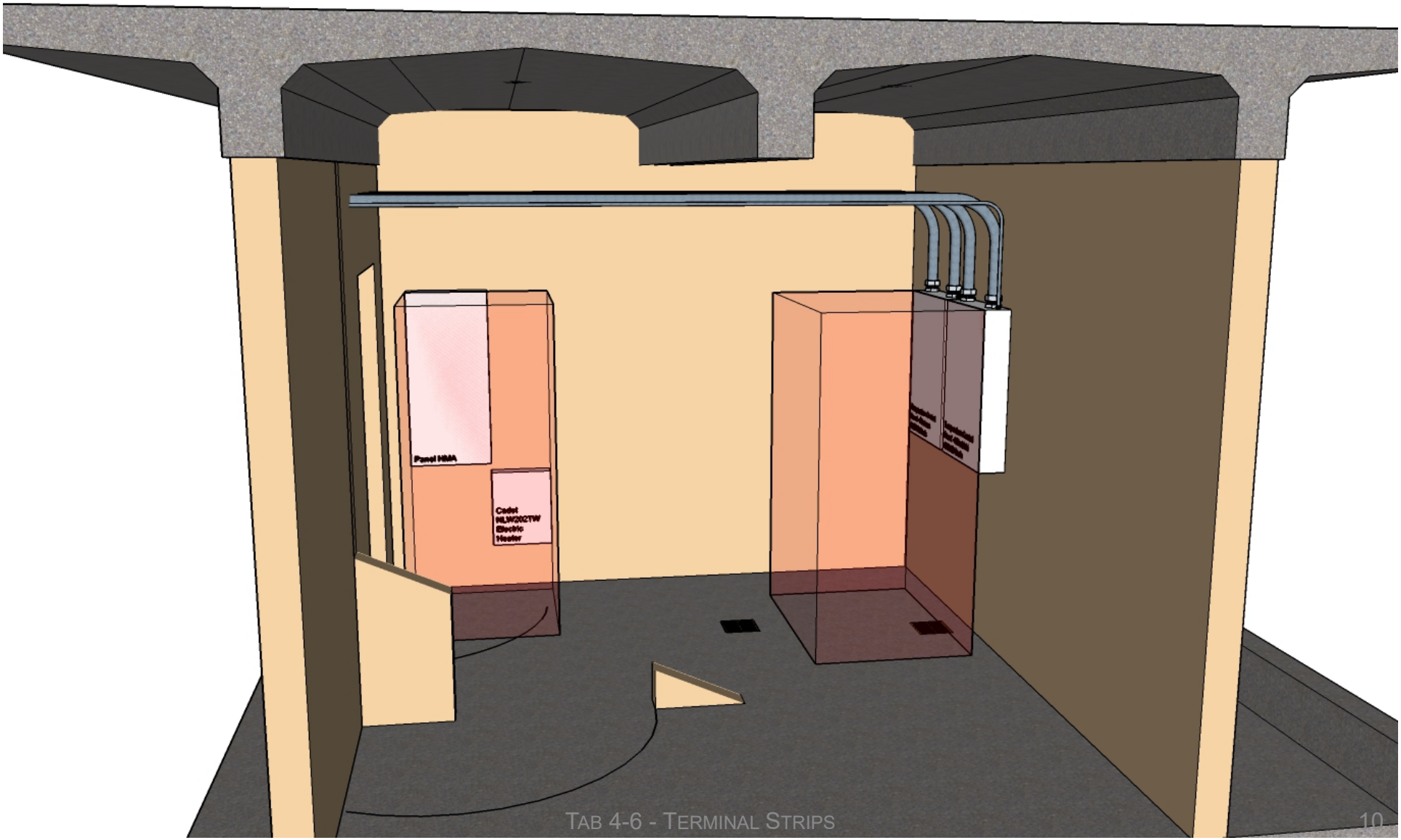
NEC Article 725

- Places limitations on the power that can be delivered through a cable
  - Voltage limits
  - Current limits
- Class 1
  - Two types
  - Digital outputs
- Class 2 and 3
  - Table 11
  - Digital inputs, analog inputs, analog outputs
- Class 1 must be segregated from Class 2 and 3 and also high voltage wiring

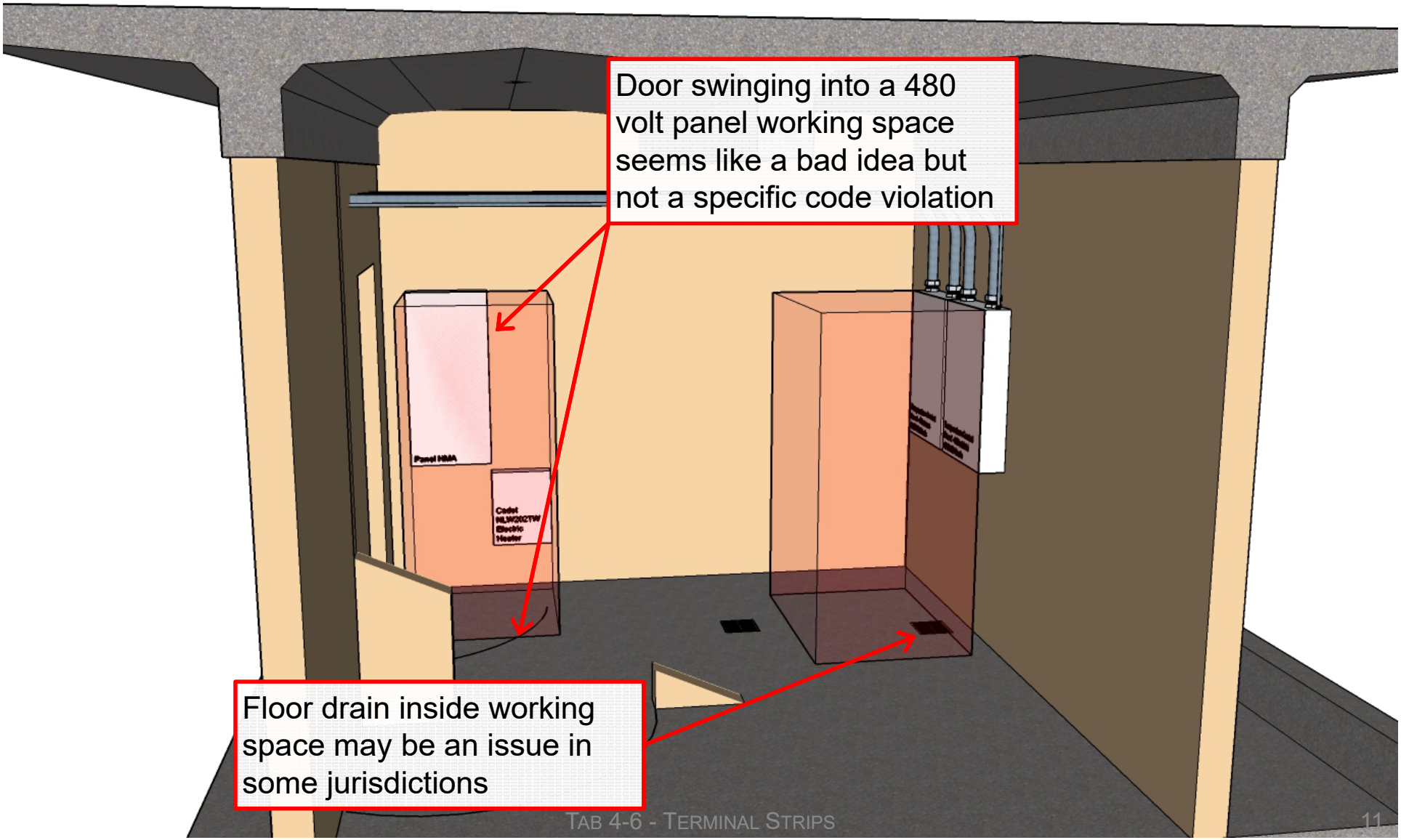
Working Space Requirements

- Concerned with clearance to grounded objects
  - Table 110.26
  - Different requirements for different voltages to ground
  - Different requirements for different defined conditions
  - For most control systems
    - 3 feet in front of the panel
    - You have to be able to open the door
    - The space extends from the floor to 6’6” or the top of the panel

Working Space; An Example

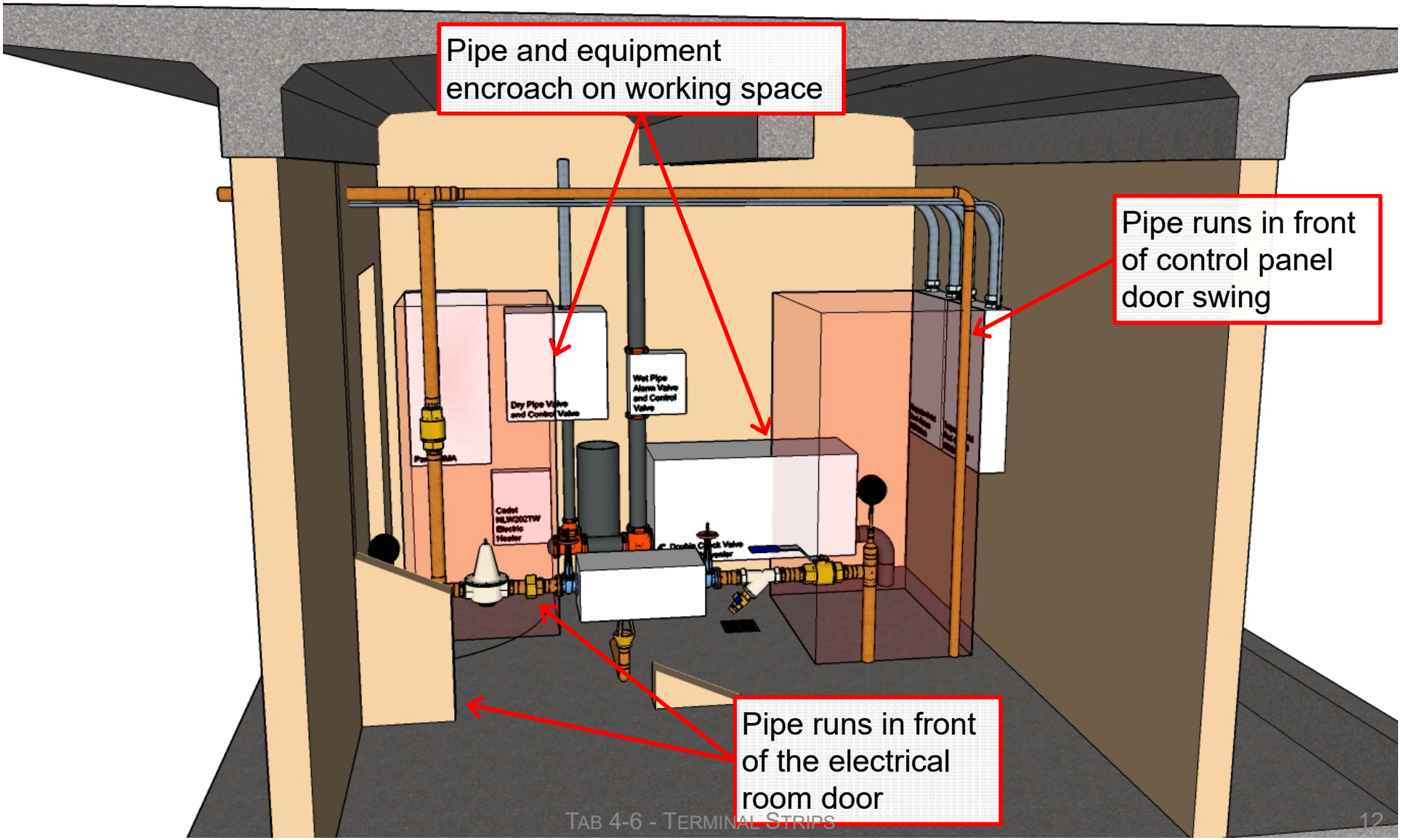


Working Space; An Example
Coordinated at 60% CDs; Everything Looks Fine



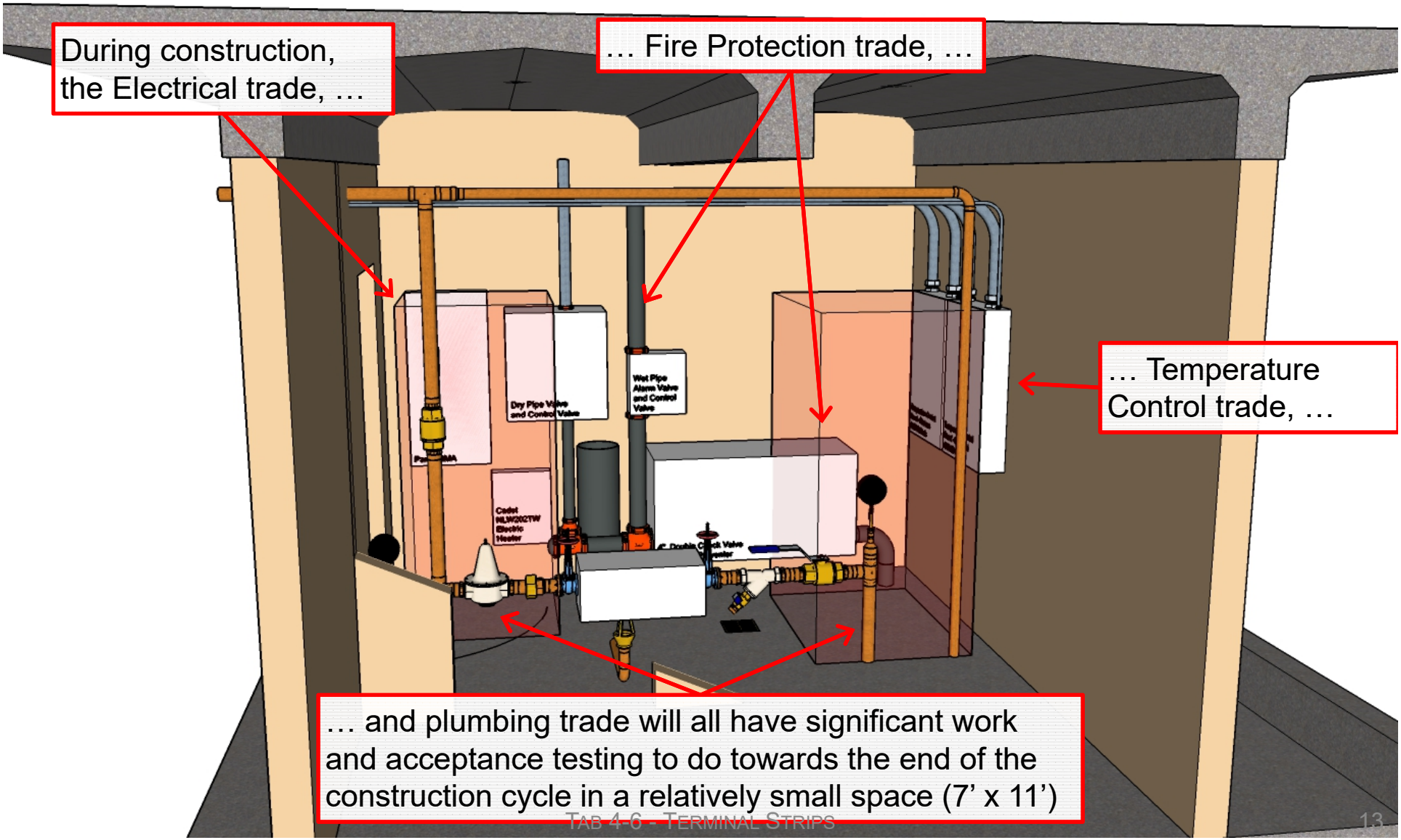
Working Space; An Example

Situation at 90% CDs; A Few Coordination Issues Show Up



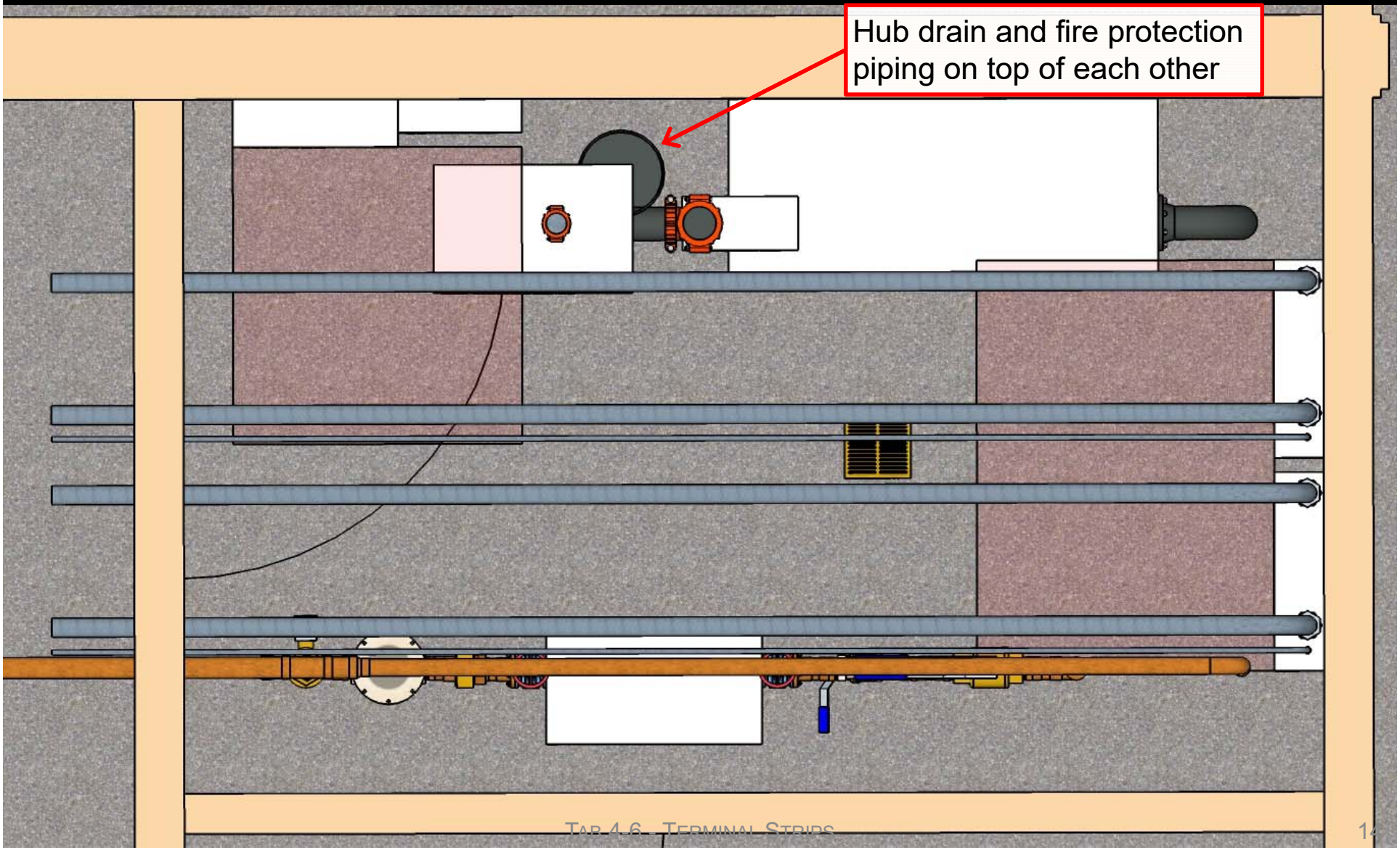
Working Space; An Example

Situation at 90% CDs; A Few Coordination Issues Show Up



Working Space; An Example

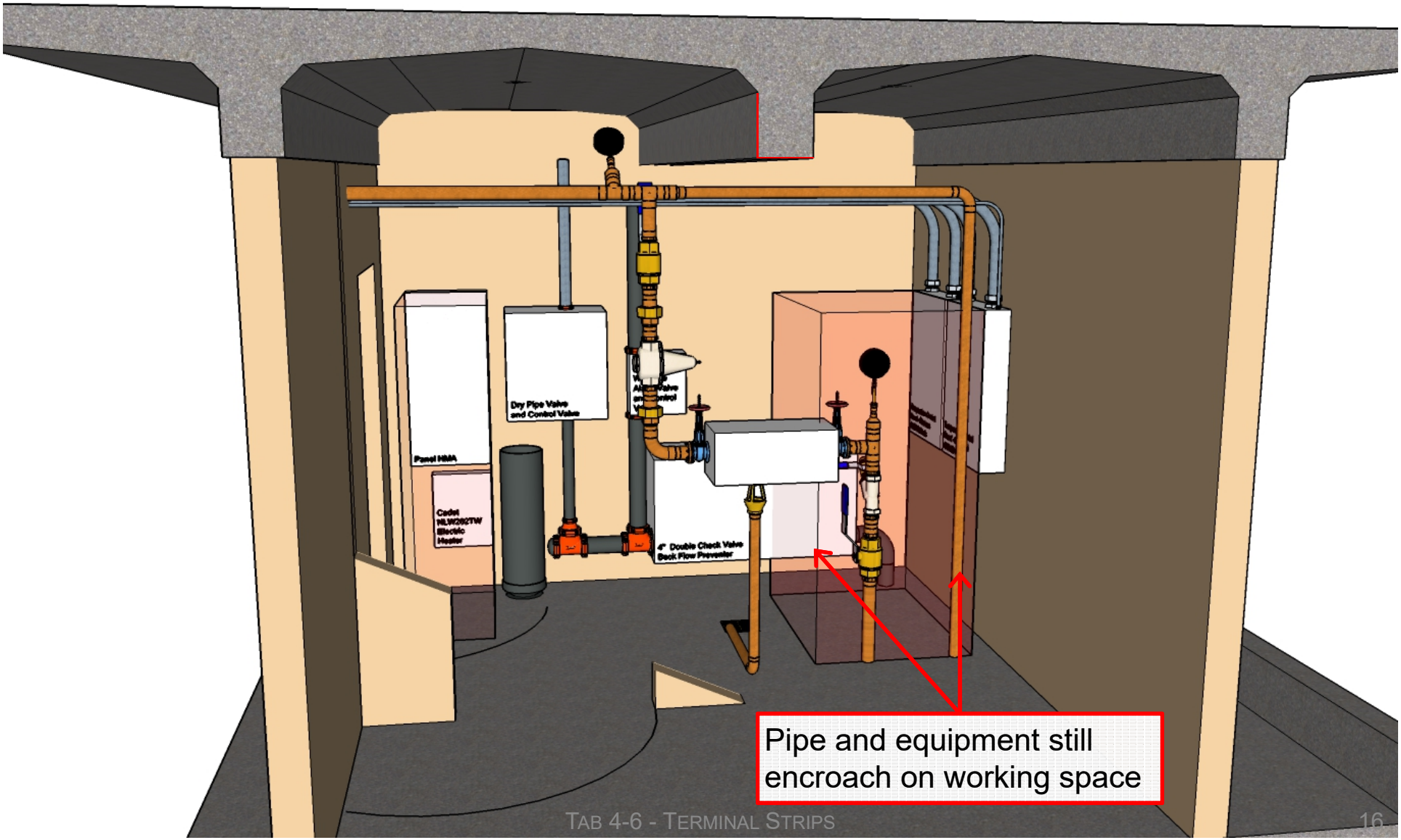
Situation at 90% CDs; A Few Coordination Issues Show Up



Working Space; An Example
Other Than Those Items, It Should Be Fine

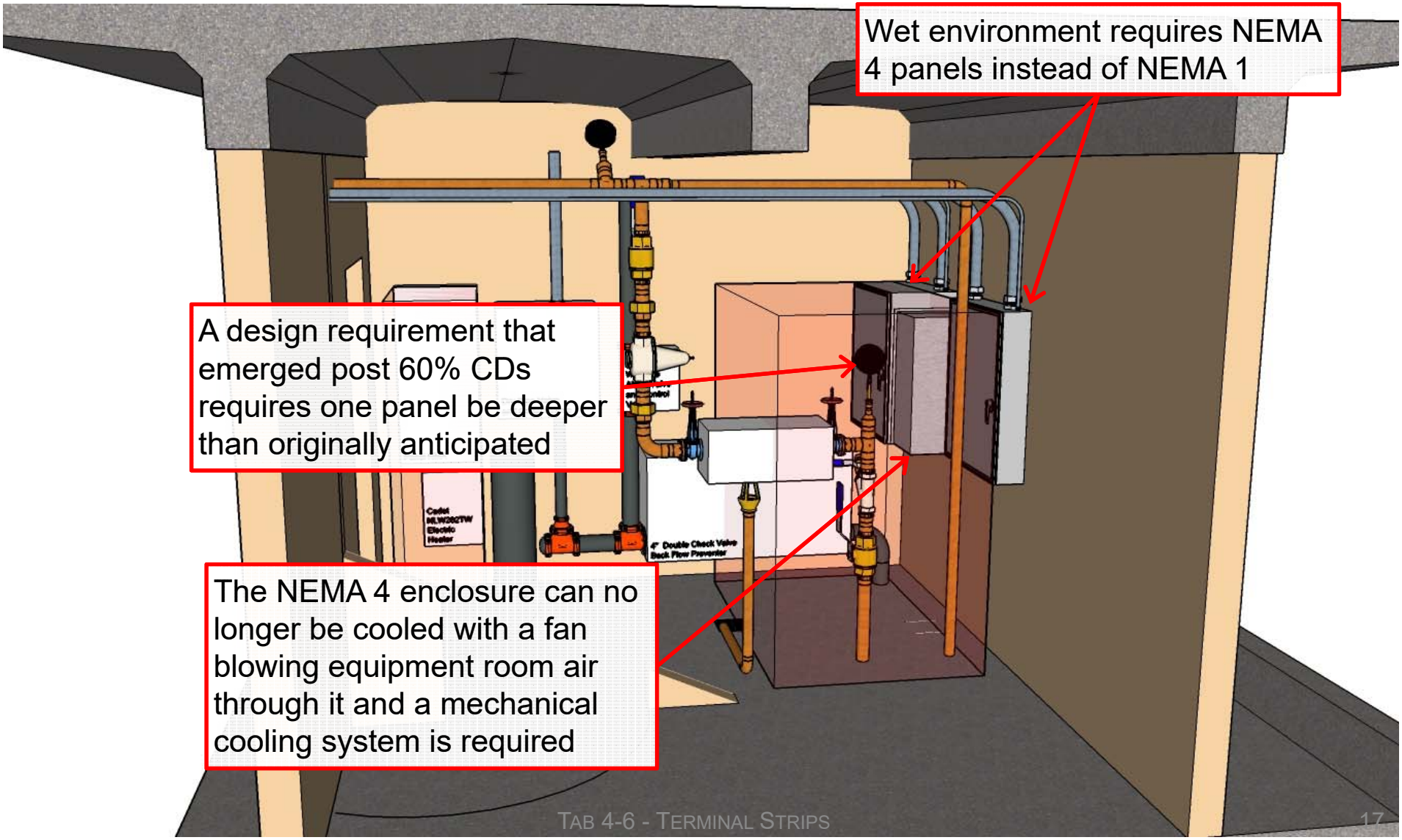
Working Space; An Example

Resolving the Non-Control System Coordination Issues



Working Space; An Example

A Few (and New) Control System Coordination Issues Remain



Working Space; An Example

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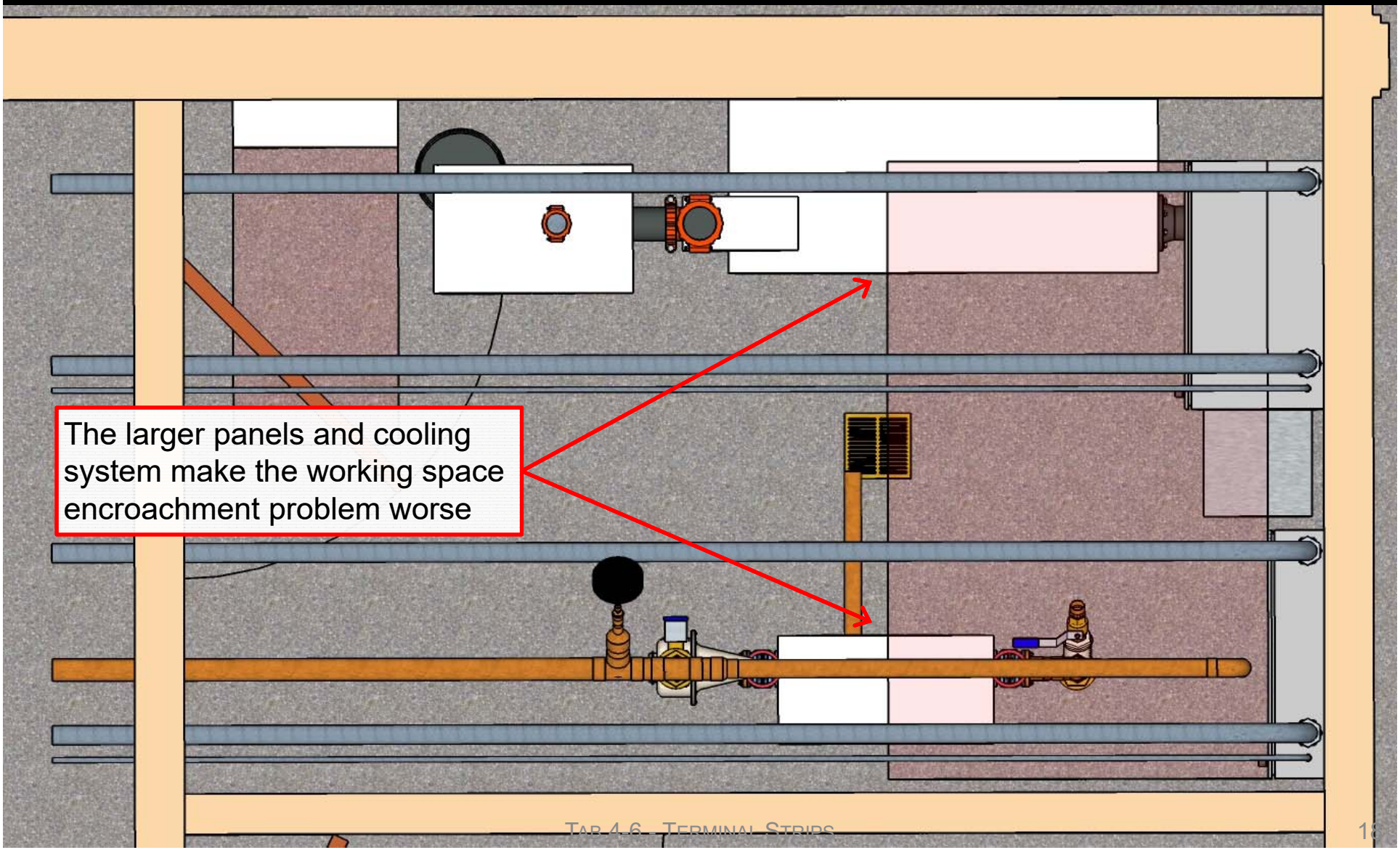

Working Space; An Example

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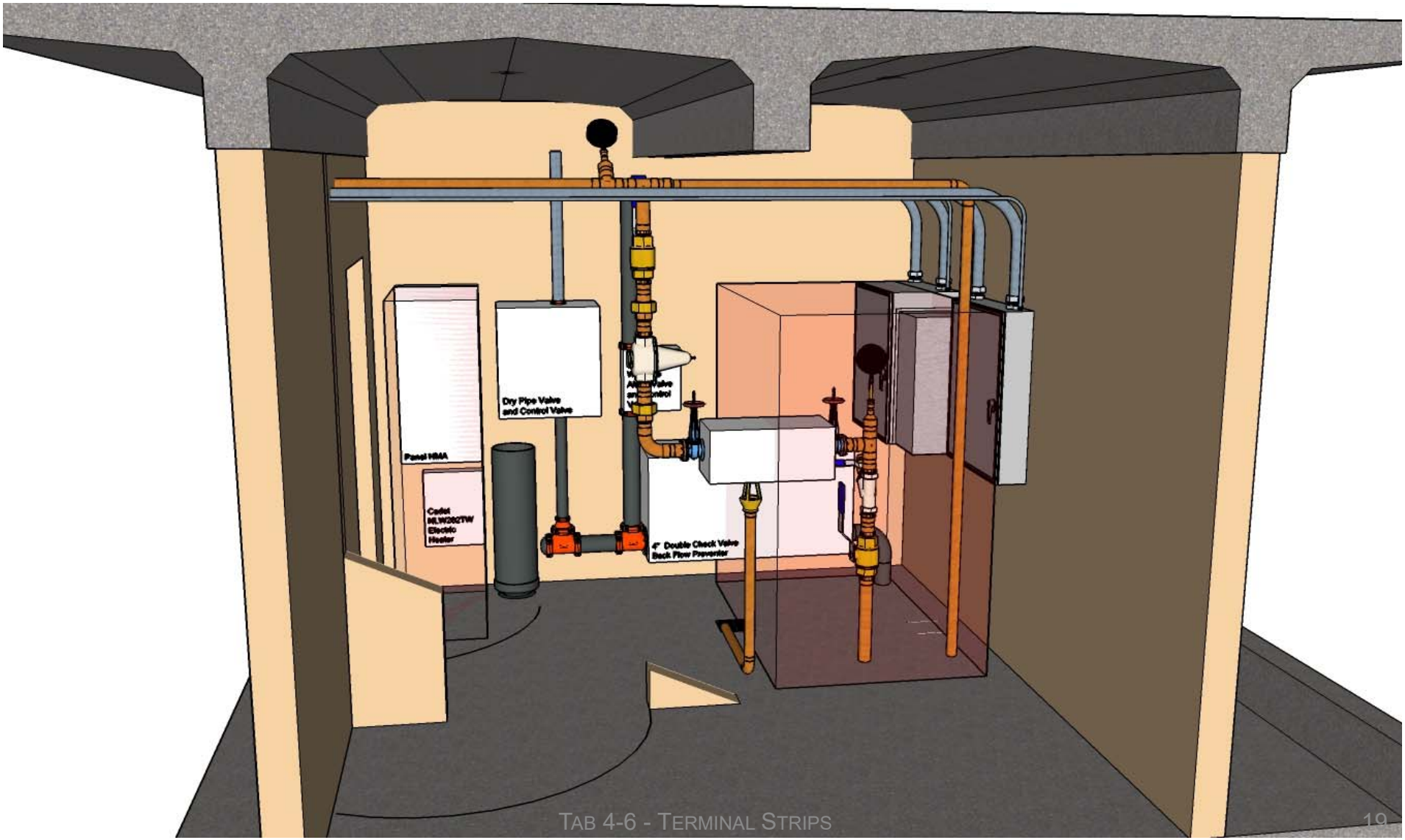
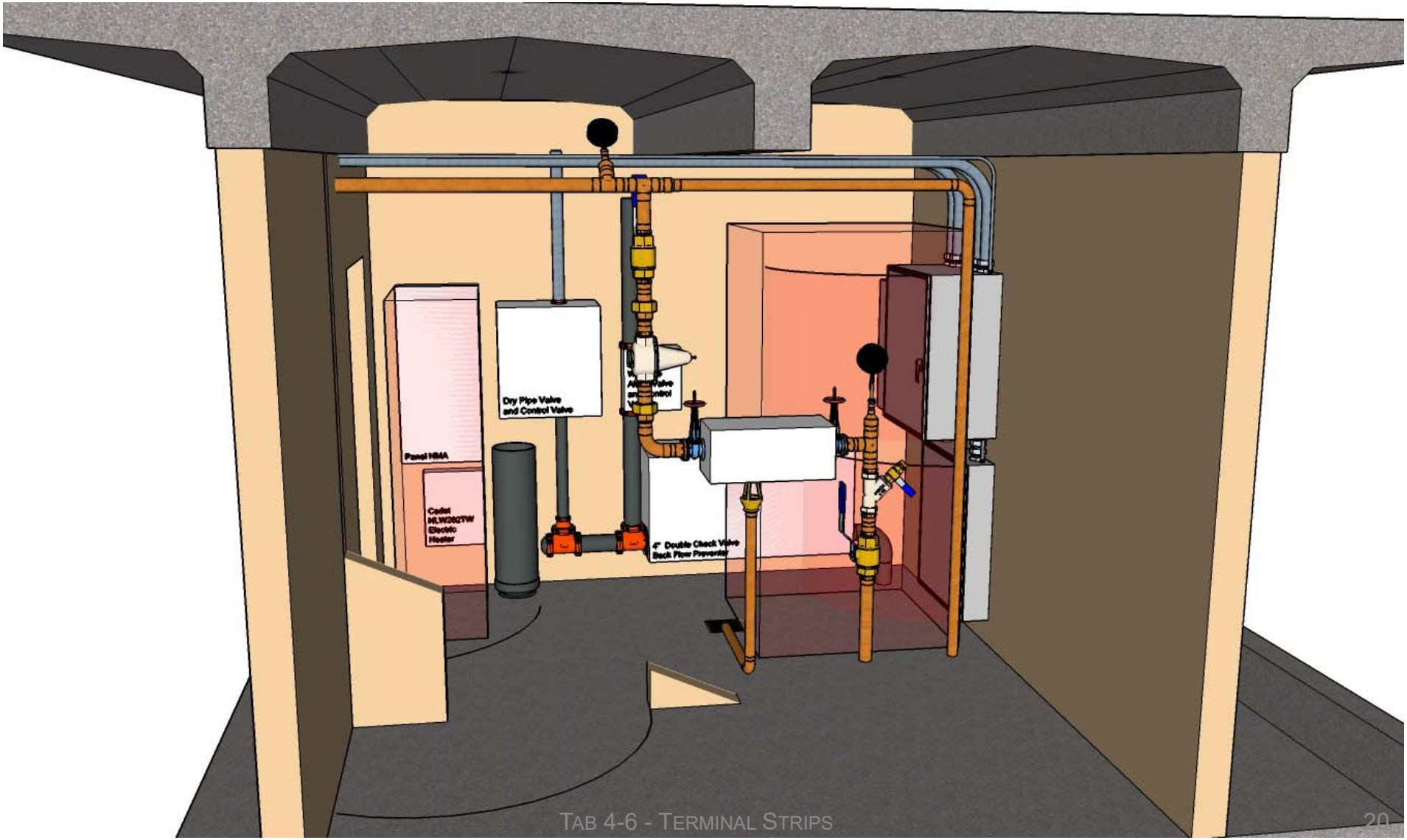
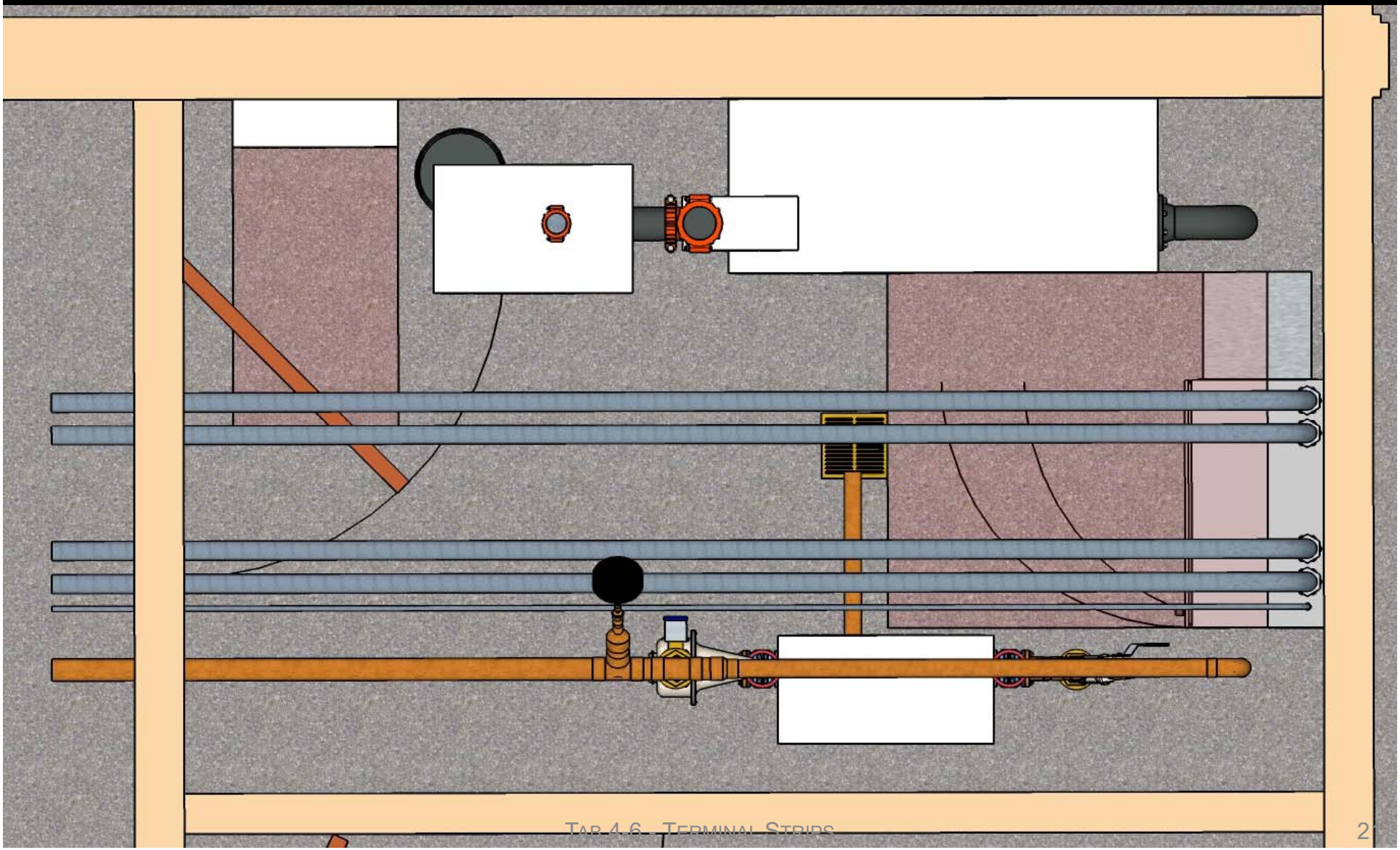


Working Space; An Example
Solving the Problem



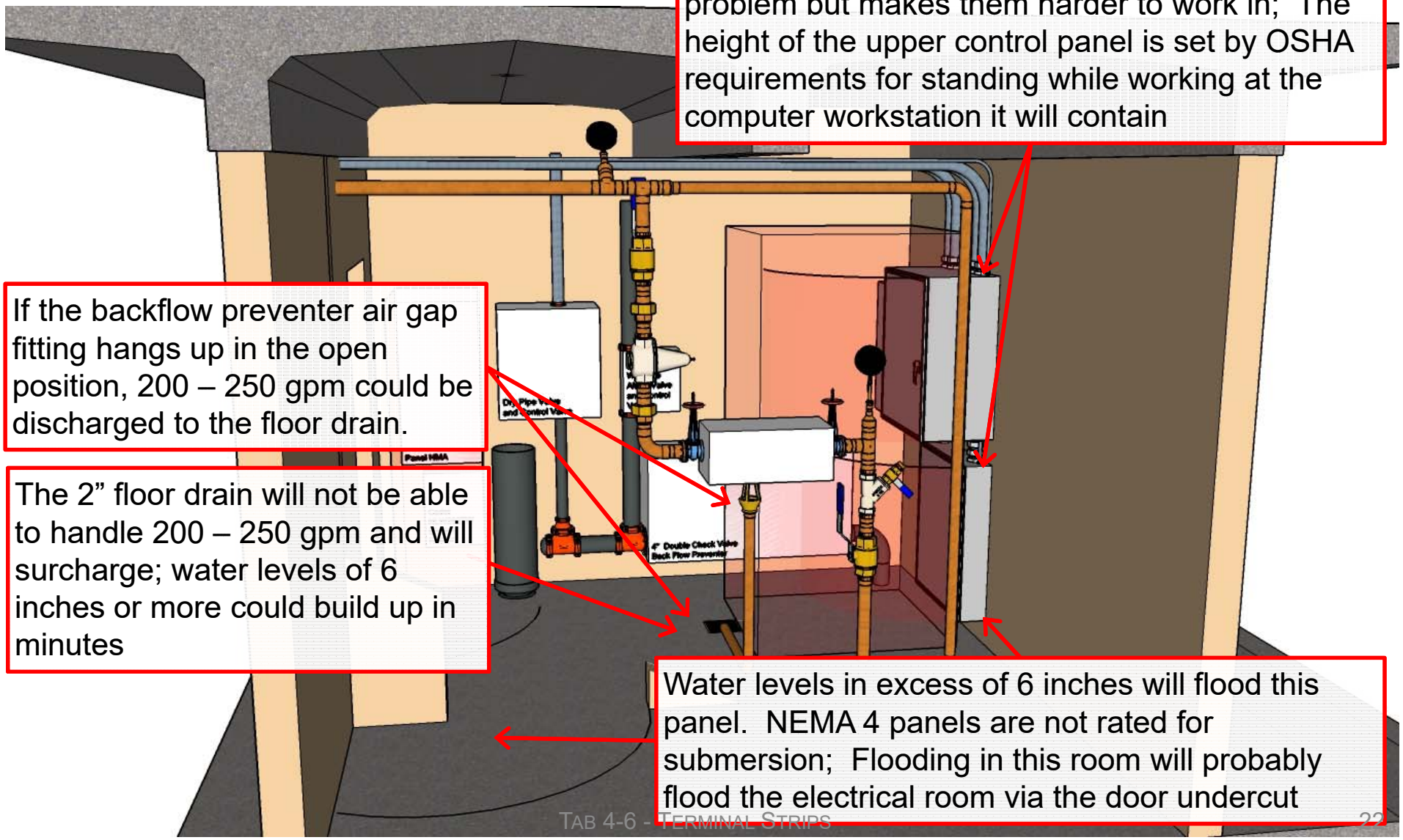
Working Space; An Example

Solving the Problem (Barely)



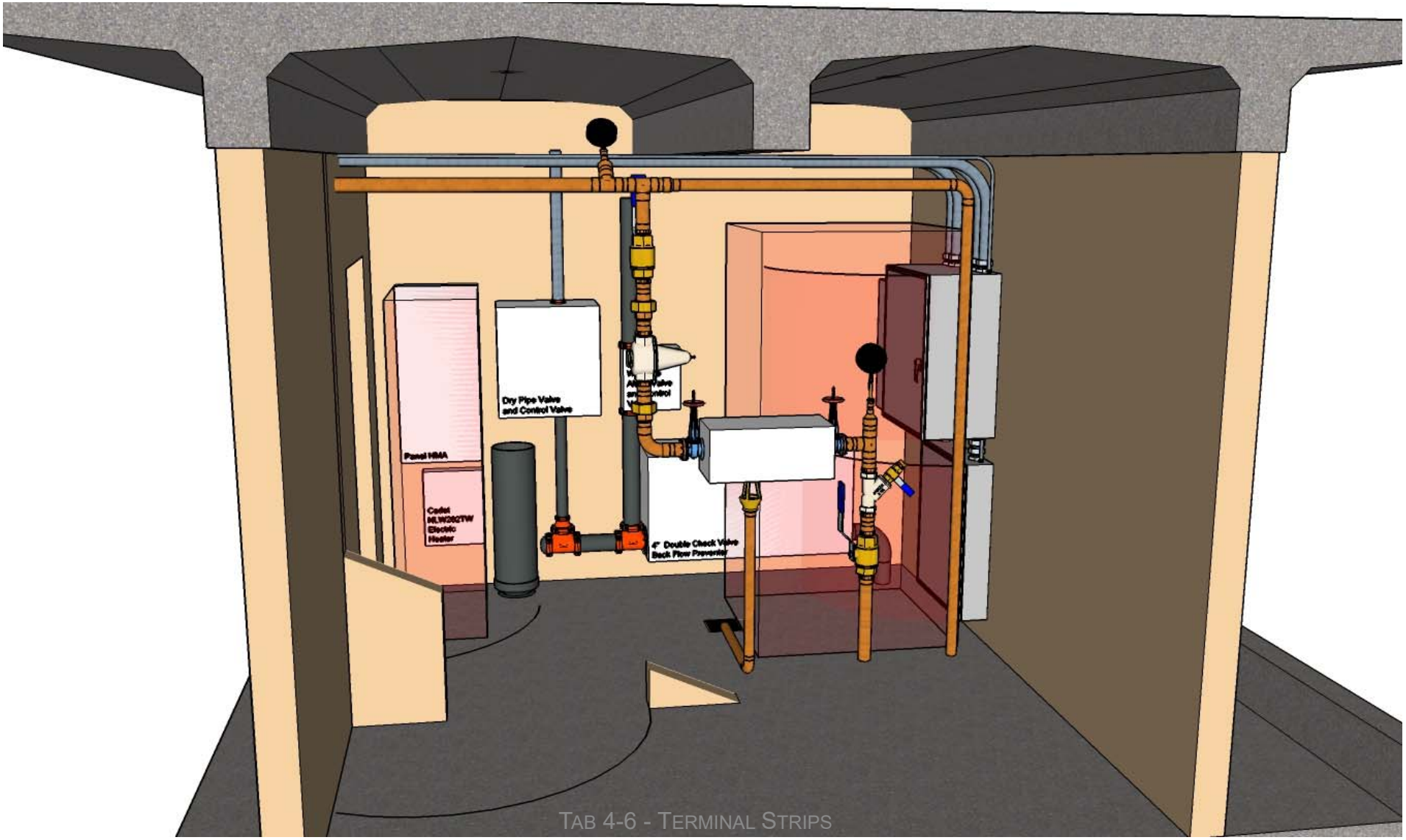
Working Space; An Example

Still a Few Issues



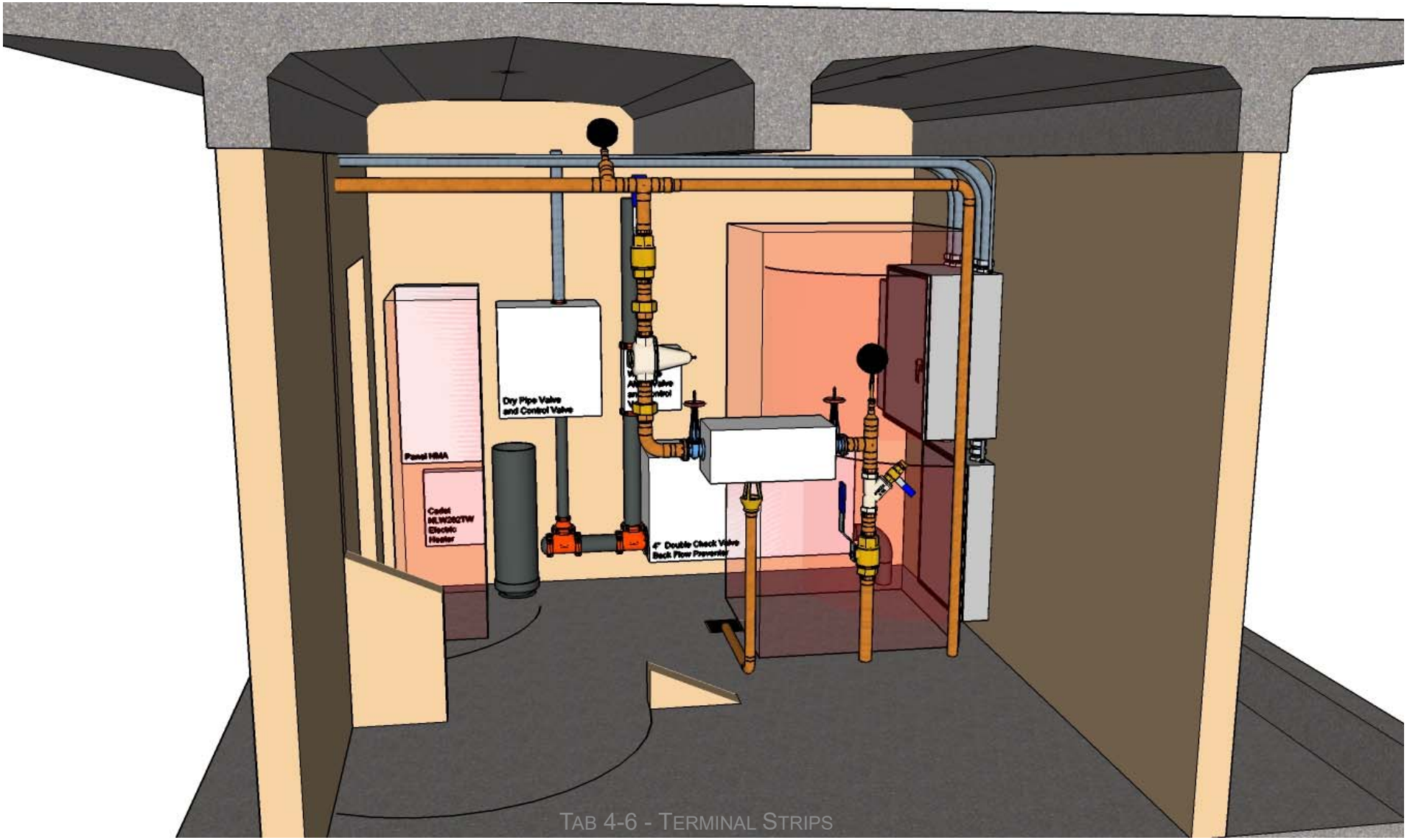
Working Space; An Example

Why not move the panels to a different room?



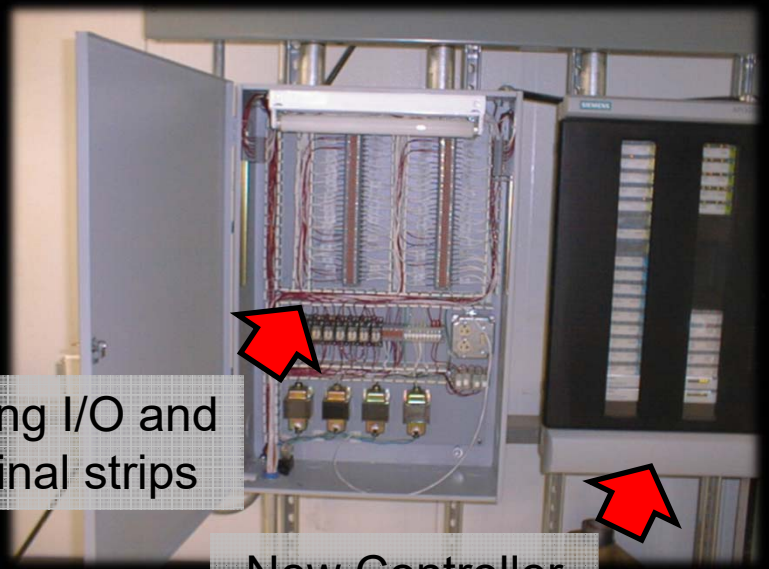
Working Space; An Example

The Architect says “No we coordinated at 60%; live with it”



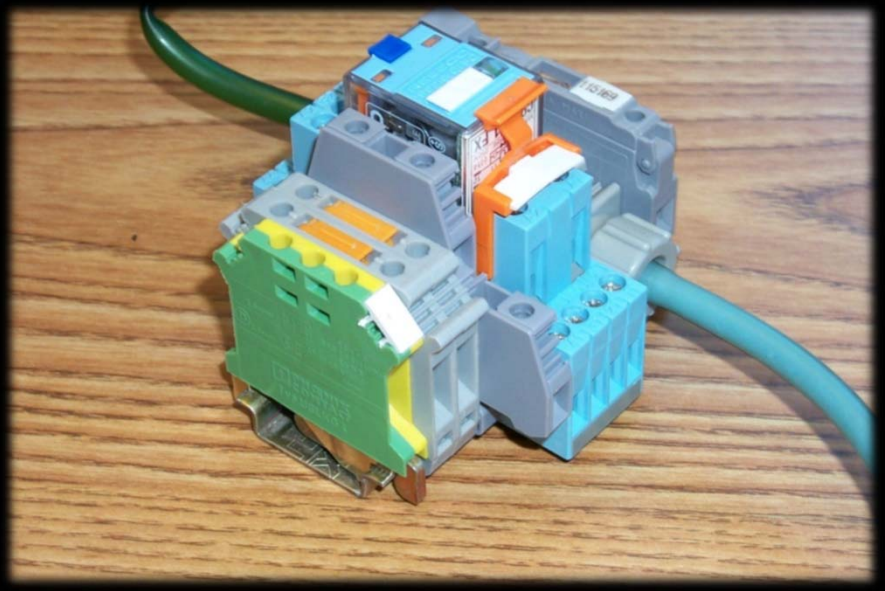
Terminal Strips; An Up-front Investment with Short and Long Term Benefits

The Towers Dorm Complex was one of several facilities where an Allen Bradley PLC based monitoring system was upgraded to a Siemens System using the original sensors and wiring.



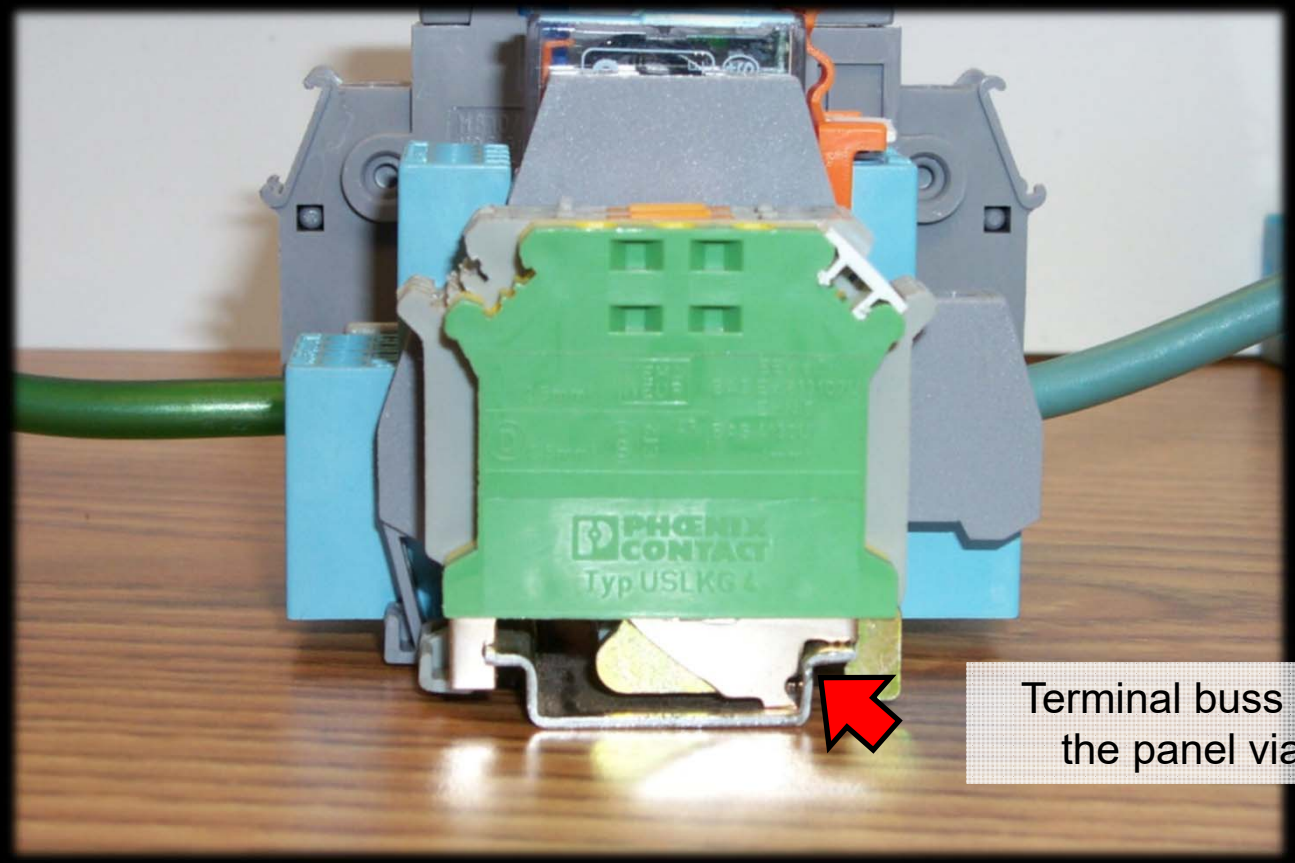
Terminal Strips; An Up-front Investment with Short and Long Term Benefits

- Expedite controller hardware replacement and upgrades
- Provide a contractual boundary
- Enhance labeling and identification
- Simplify and standardize troubleshooting
- $3-$15 first cost investment = life cycle savings that pays for itself many times over



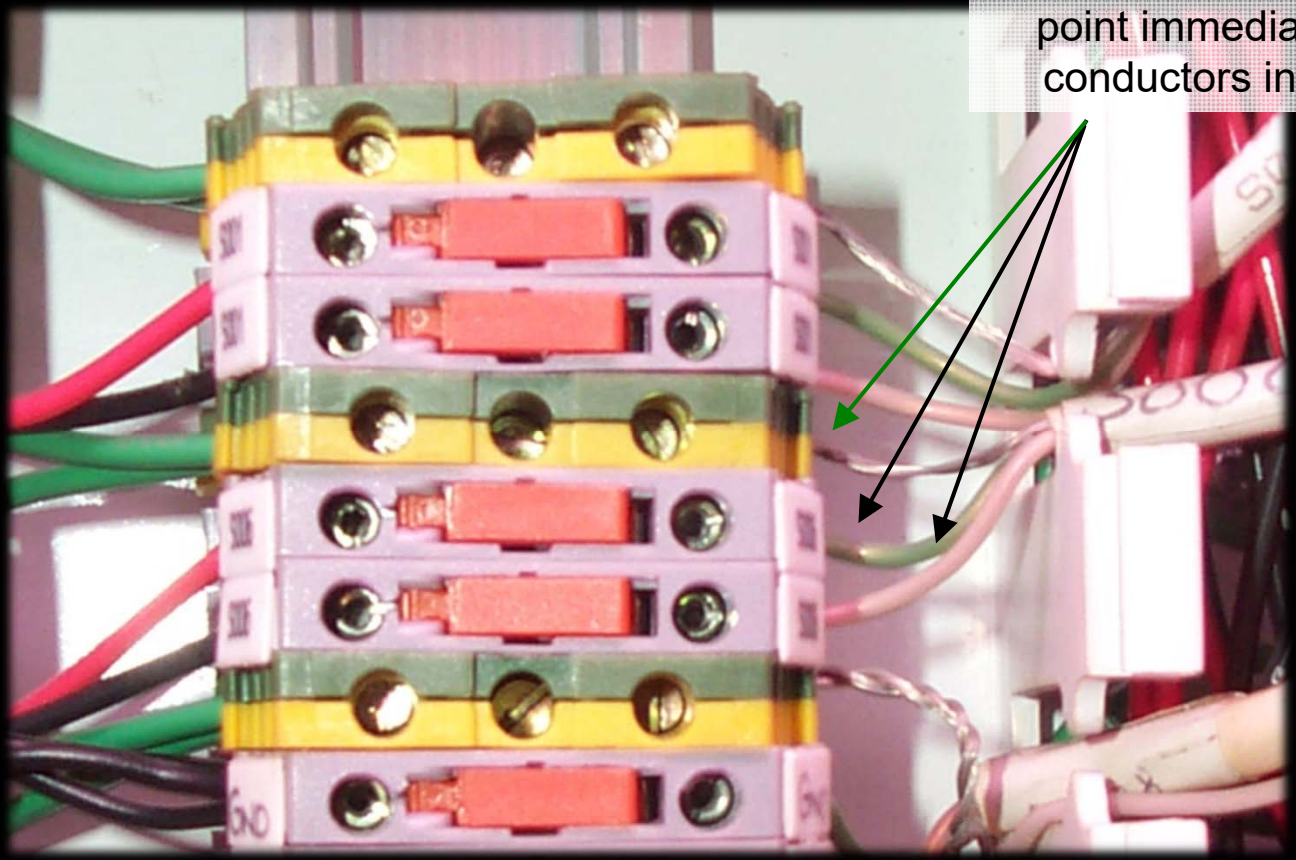
Grounding Terminals

Minimize EMF and RFI problems



Terminal buss grounded directly to the panel via the mounting rail

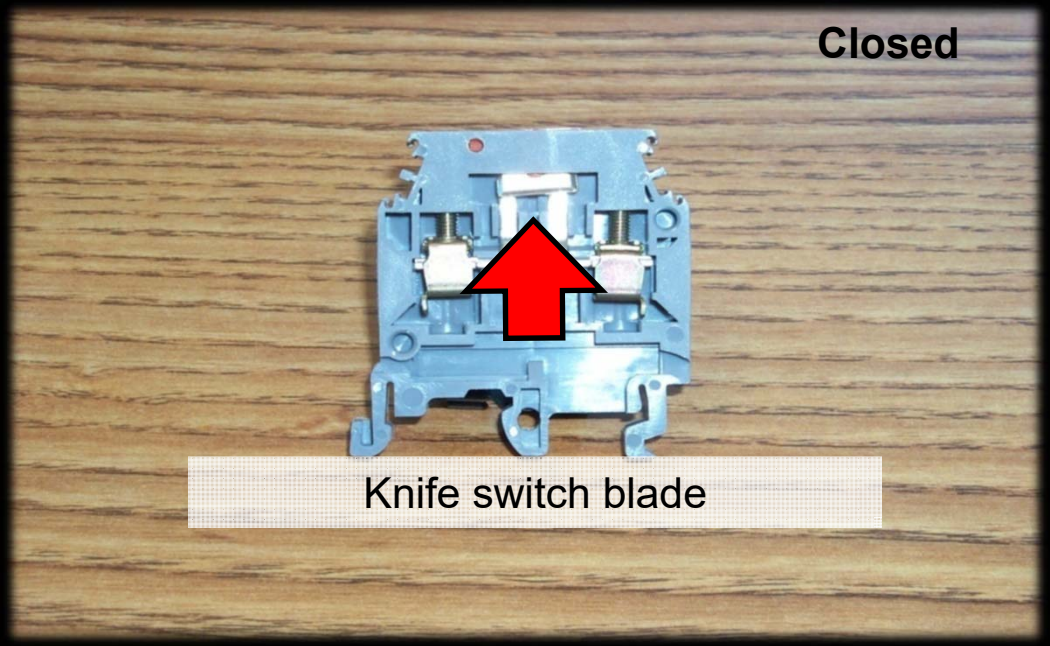
Grounding Terminals
Minimize EMF and RFI problems



Switch Blocks;
Aid Troubleshooting and Maintenance

Disconnect wiring with out lifting wires

Measure current with out interrupting operation



Switch Blocks;
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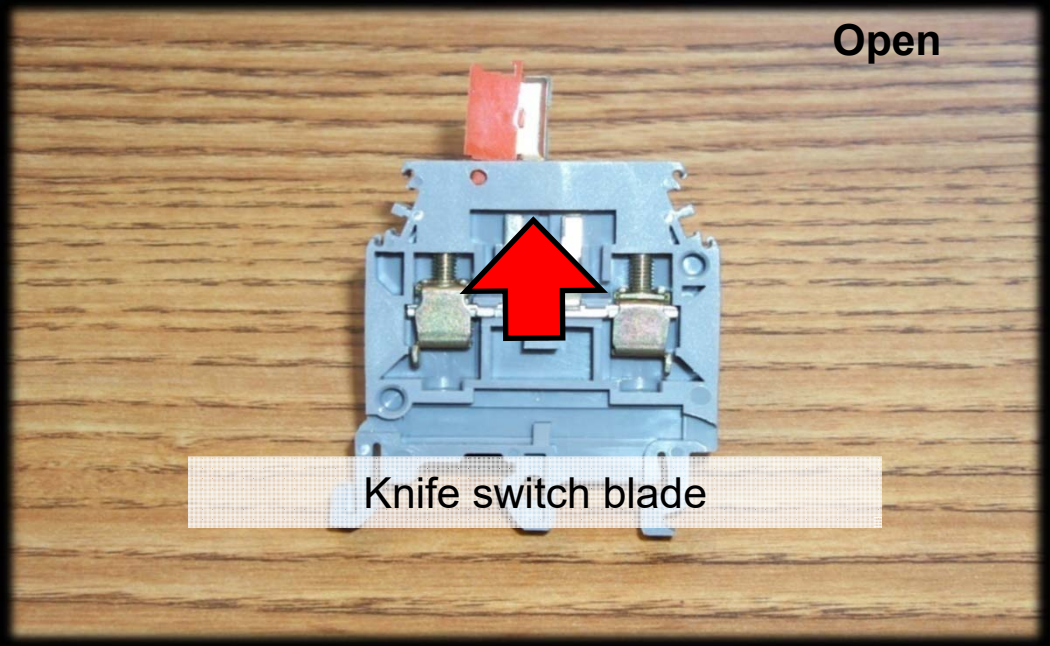
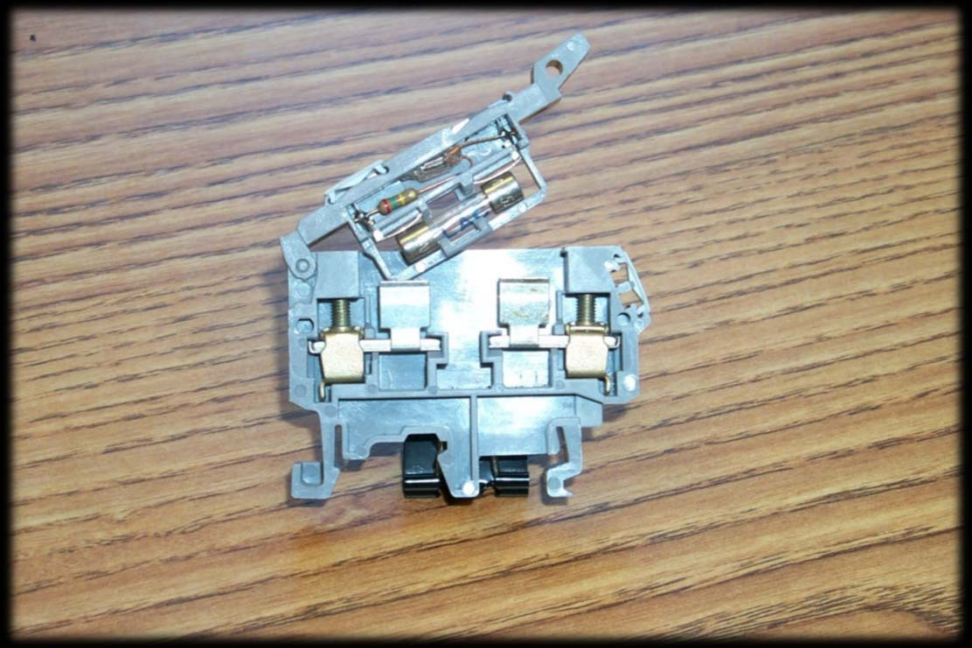


Fuse Blocks;
Enhanced System Integrity

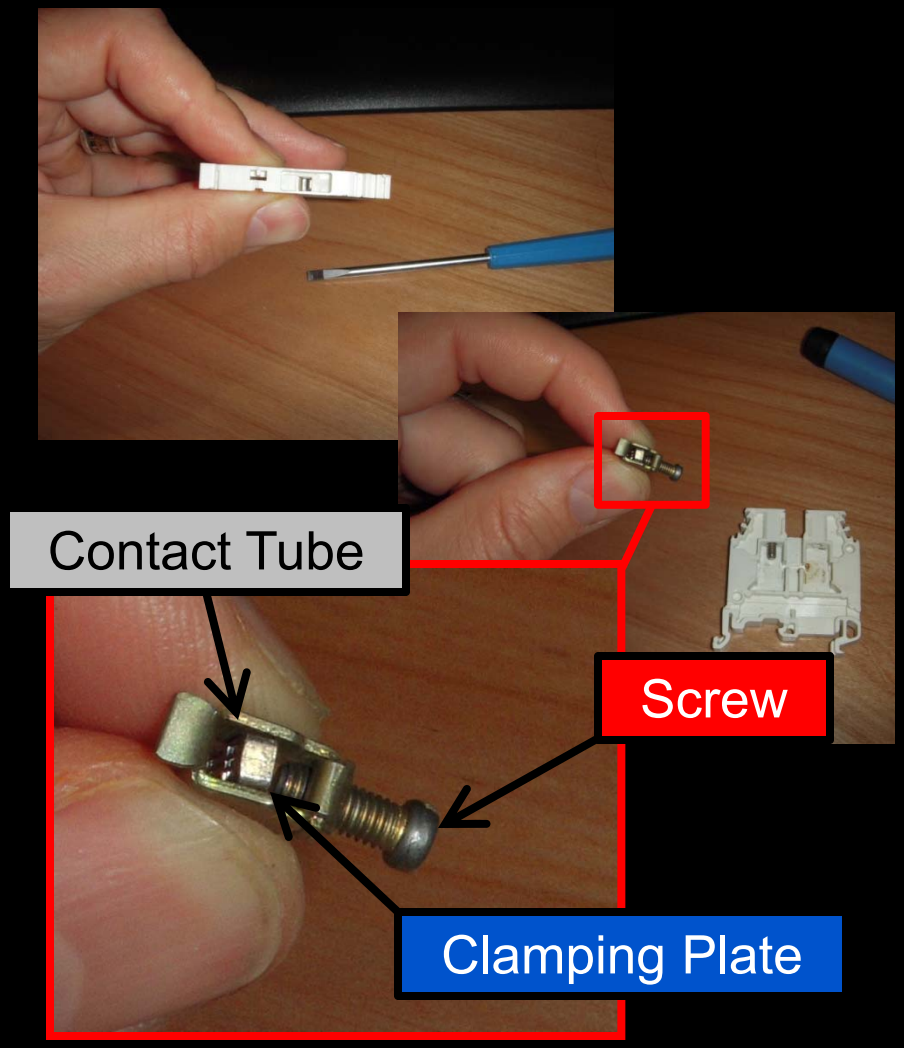
Disconnect wiring with out lifting wires

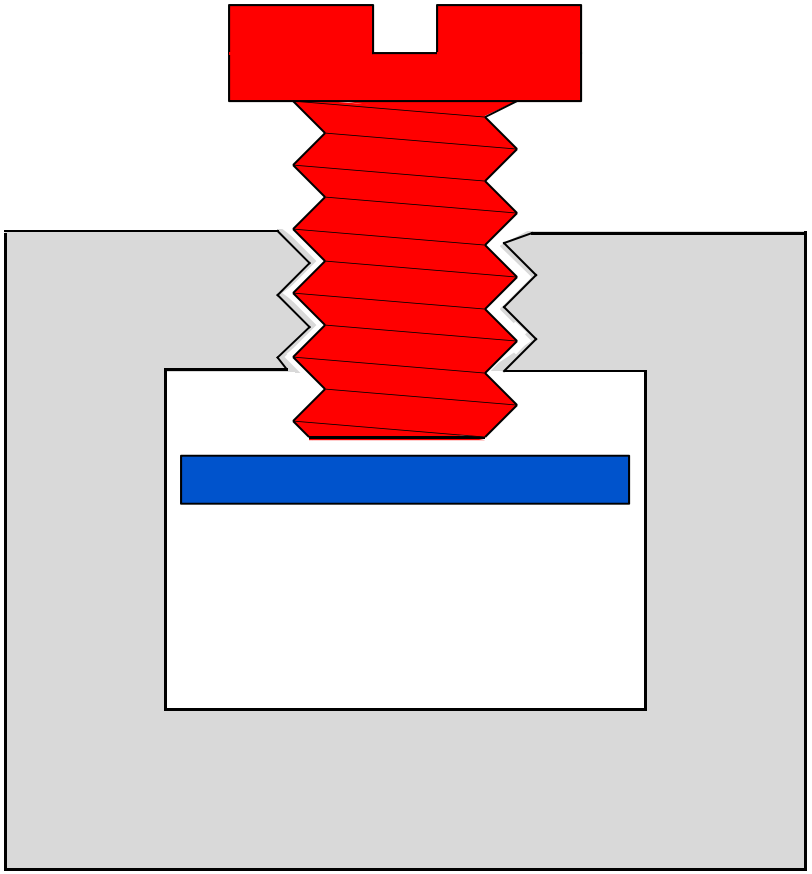
Code compliance

Fuse blown indication

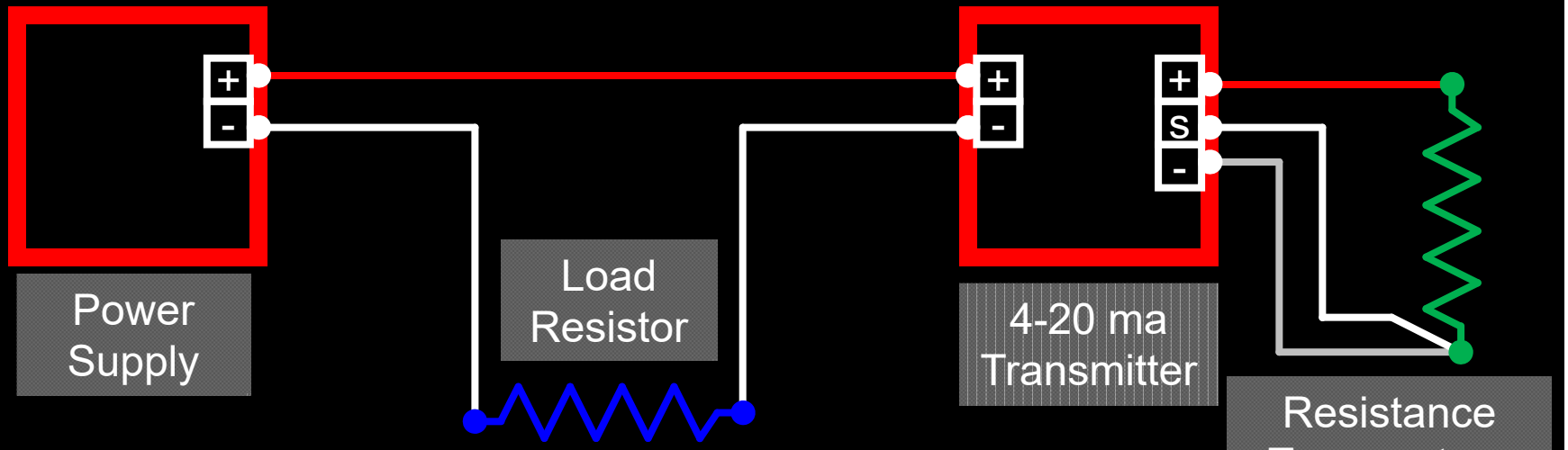


Tubular Screw Clamp Terminals



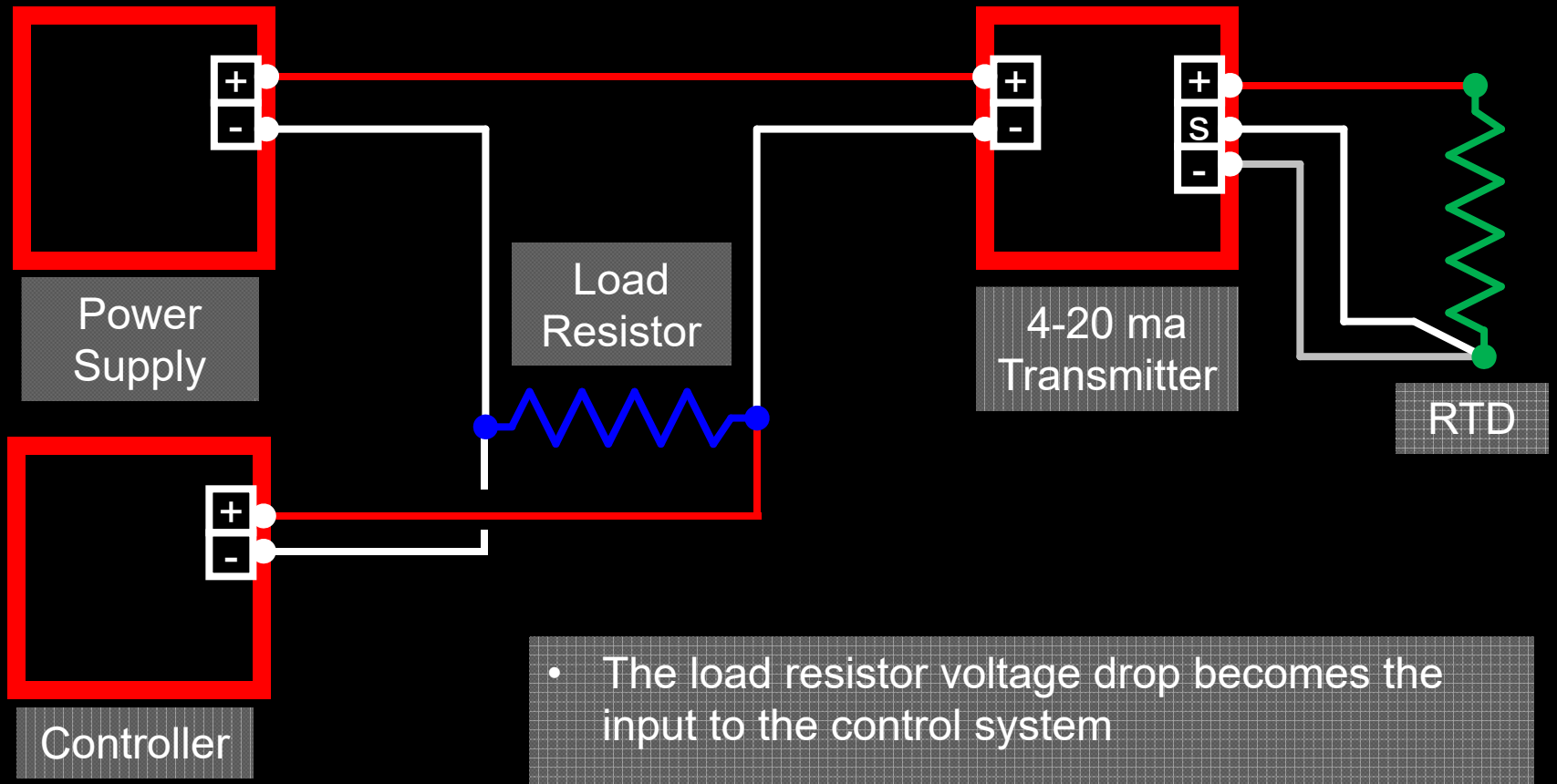


4-20 ma Transmitter Circuit Concept



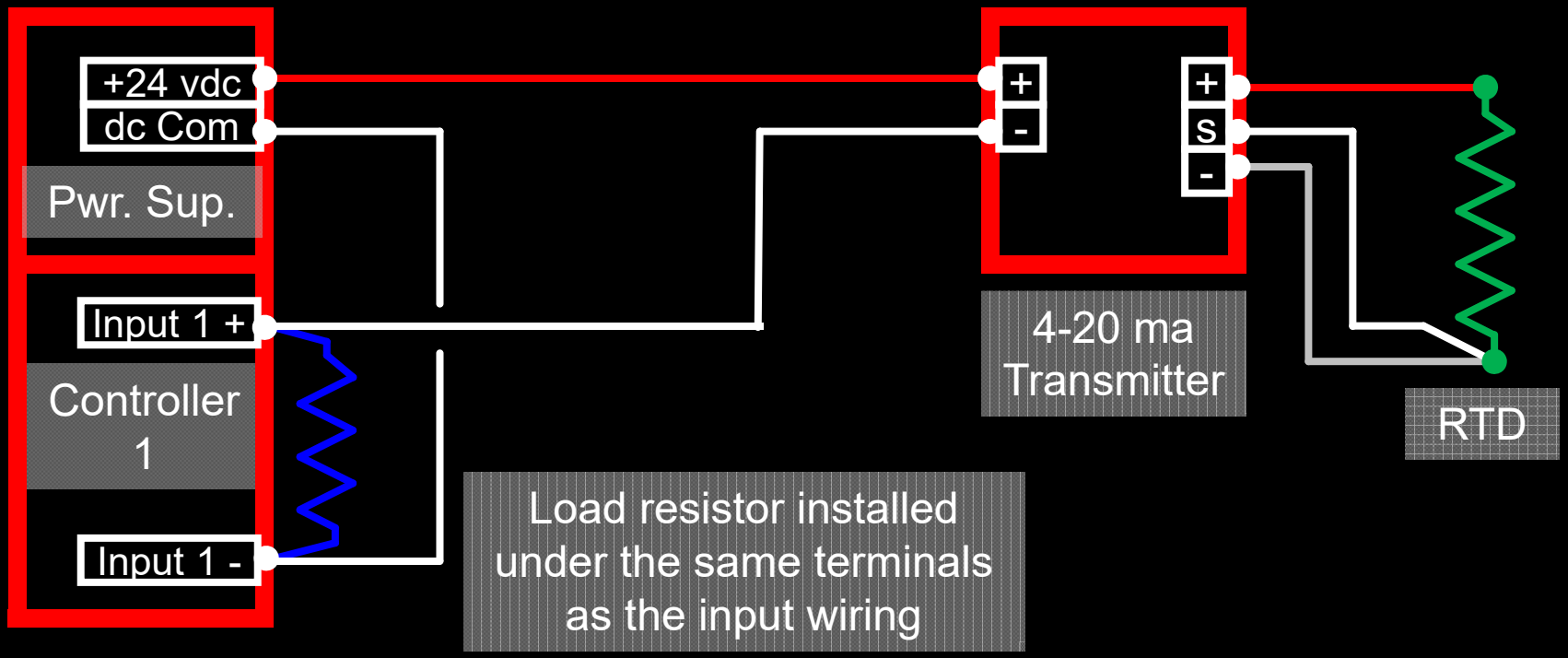
Solving E = I x R for Different Currents and Resistances				
Load resistance, ohms	250		500	
Current loop current, amps	0.004	0.020	0.004	0.020
Load resistance voltage drop, volts	1.000	5.000	2.000	10.000

4-20 ma Transmitter Circuit Concept

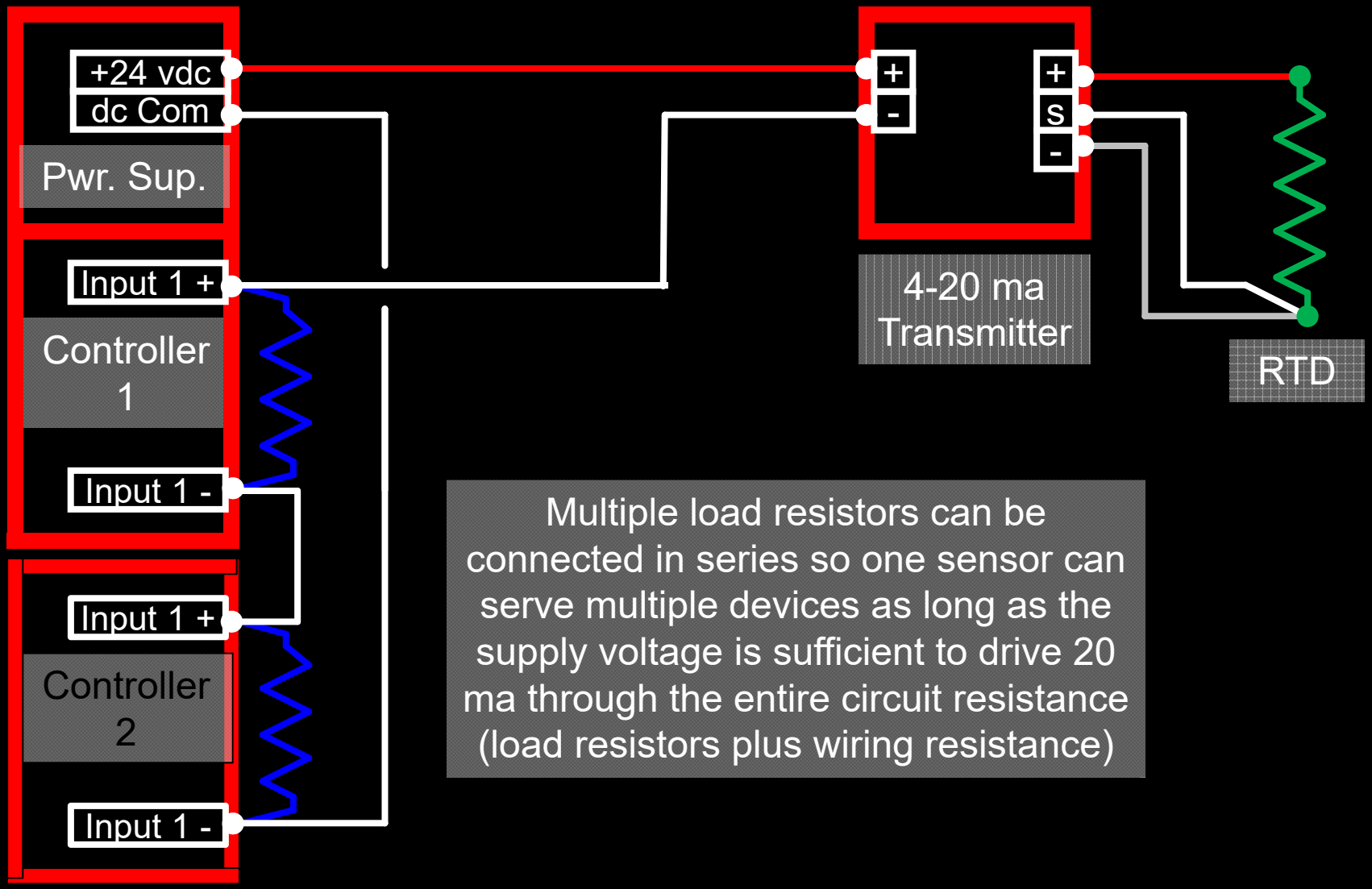


- The load resistor voltage drop becomes the input to the control system
- The loop can have multiple load resistors as long as there is sufficient voltage to drive 20ma through the total circuit resistance

4-20 ma Transmitter Circuit Concept

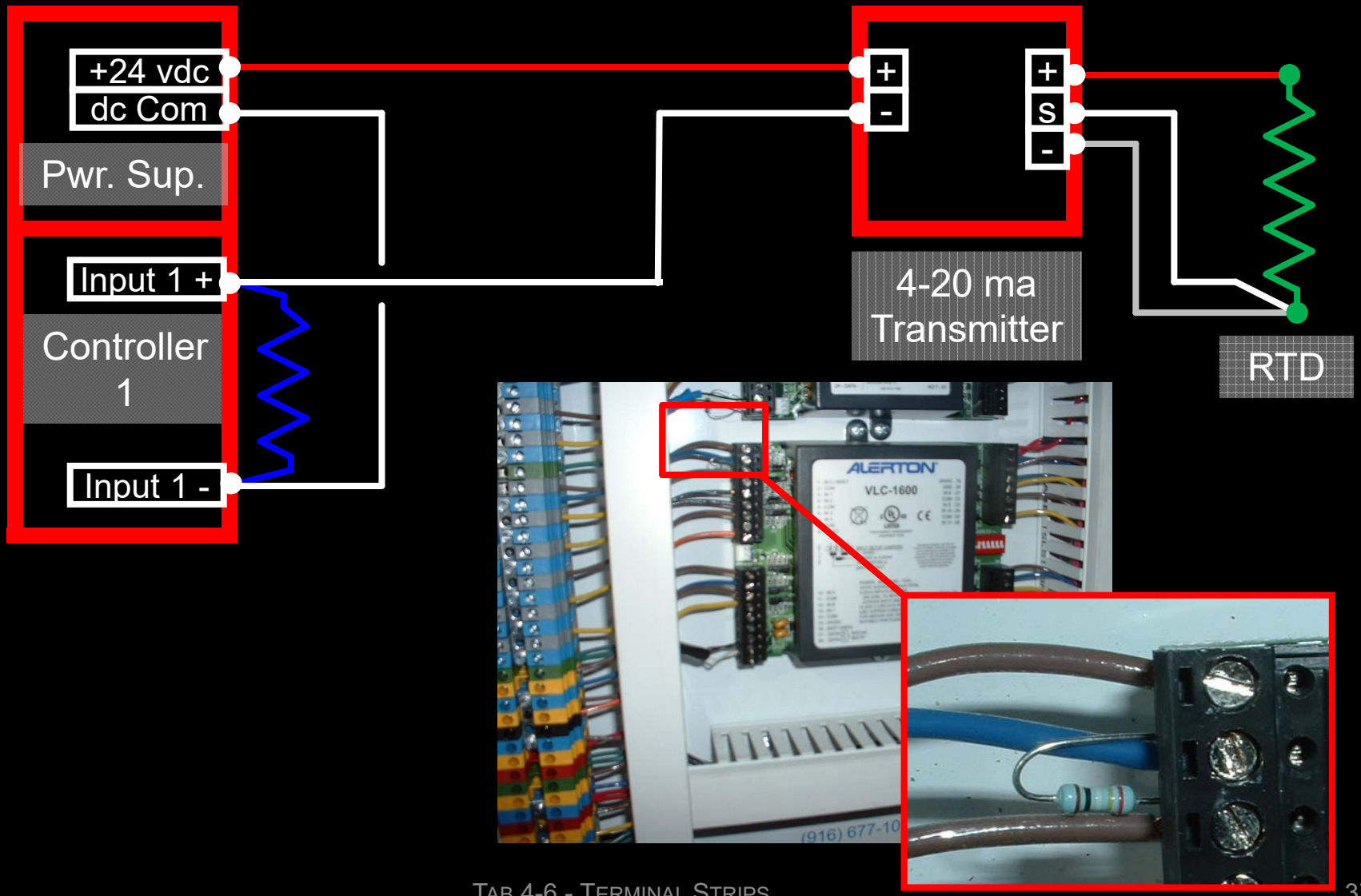


4-20 ma Transmitter Circuit Concept

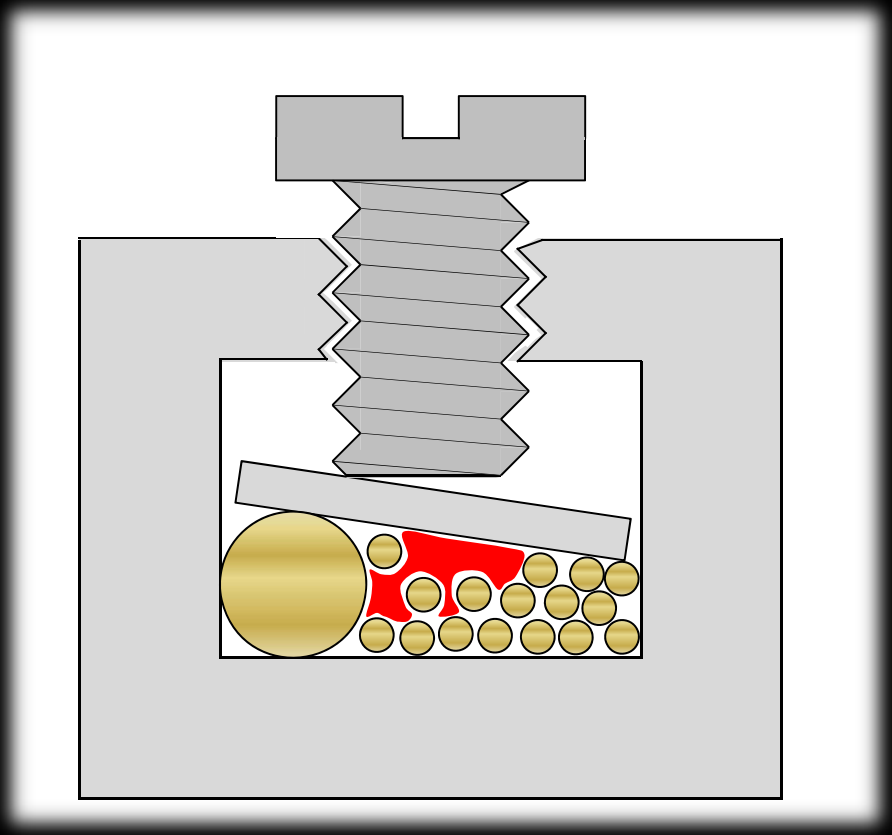


Multiple load resistors can be connected in series so one sensor can serve multiple devices as long as the supply voltage is sufficient to drive 20 ma through the entire circuit resistance (load resistors plus wiring resistance)

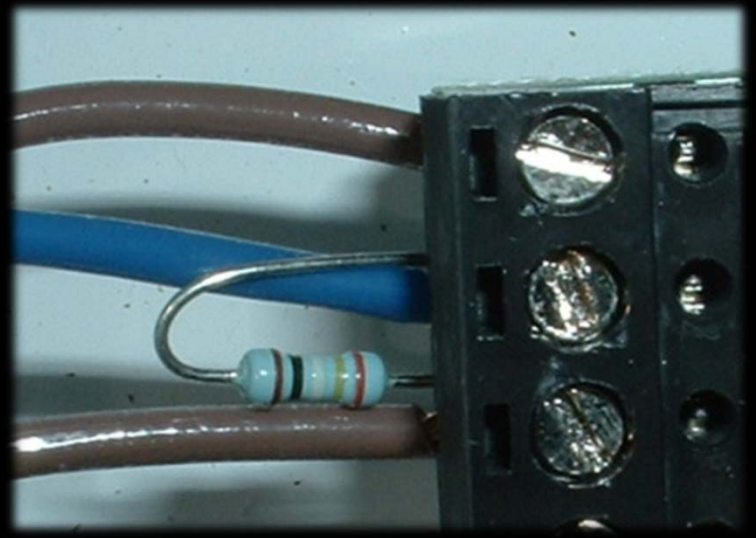
4-20 ma Transmitter Circuit Concept



4-20 ma Field Wiring Issue



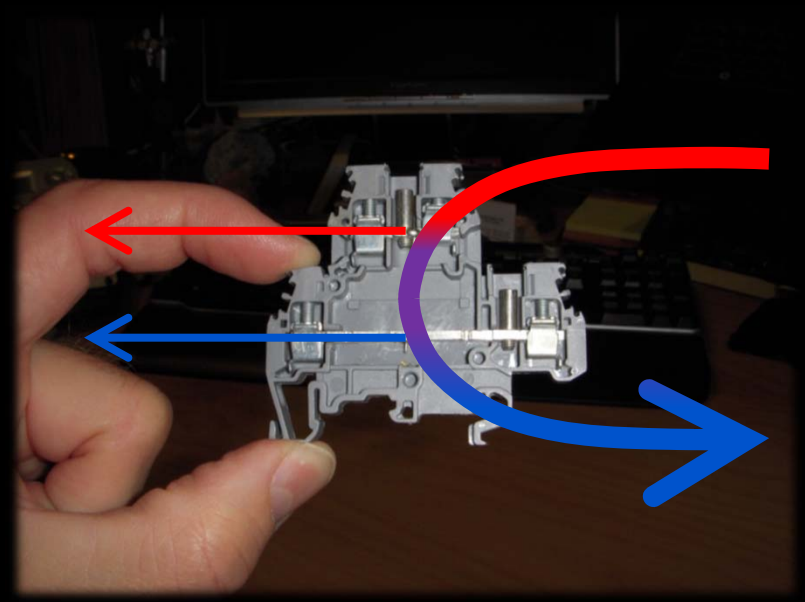
Space between conductors = Loose grip



Loose grip = Loose connection

Loose connection = Poor data integrity

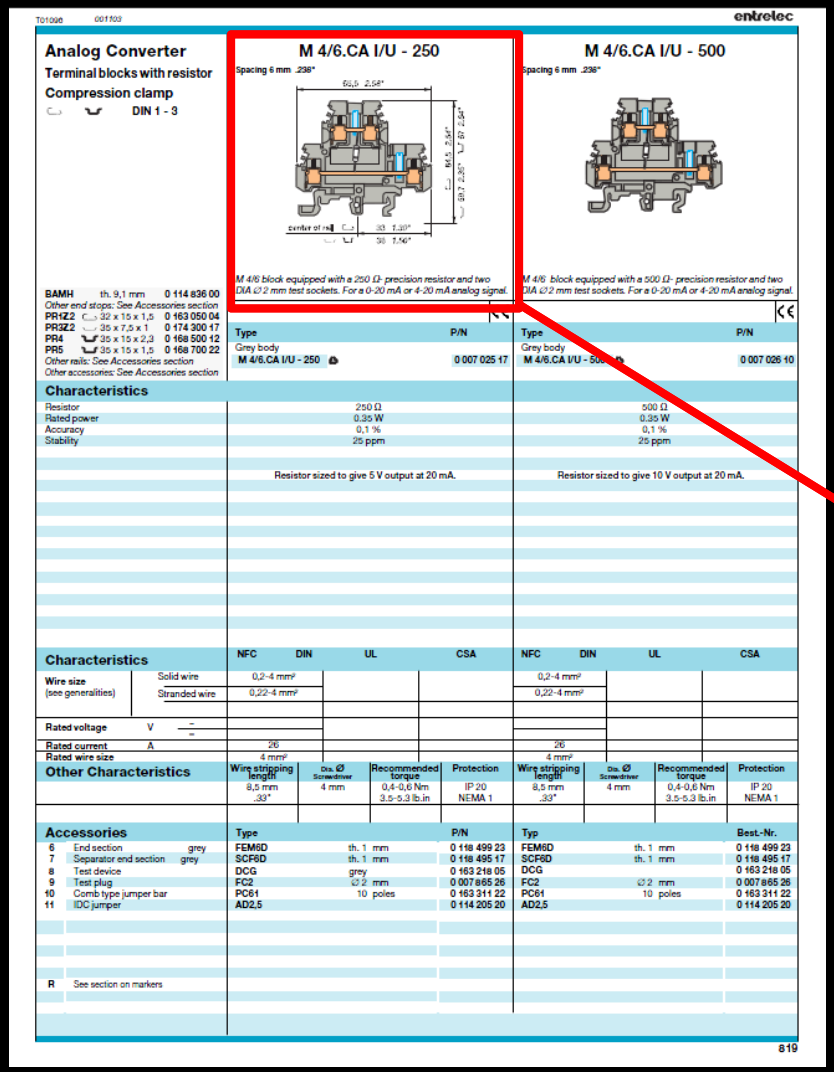
4-20 ma Field Wiring Solution



Resistor terminal block

- Two continuous bus bars
- Precision resistor brazed between the buss bars
- Current loop flows through the resistor on one side
- Voltage picked up to the controller on the other size

Entrelec's Solution



entrelec

Analog Converter
Terminal blocks with resistor
Compression clamp
DIN 1 - 3

M 4/6.CA I/U - 250

Spacing 6 mm .236"

M 4/6 block equipped with a 250 Ω- precision resistor and two DIN Ø 2 mm test sockets. For a 0-20 mA or 4-20 mA analog signal.

M 4/6.CA I/U - 500

Spacing 6 mm .236"

M 4/6 block equipped with a 500 Ω- precision resistor and two DIN Ø 2 mm test sockets. For a 0-20 mA or 4-20 mA analog signal.

BAMH	th. 9,1 mm	0 114 836 00
PR1Z2	32 x 15 x 1,5	0 163 050 04
PR2Z2	35 x 7,5 x 1	0 174 300 17
PR4	35 x 15 x 2,3	0 168 500 12
PR5	35 x 15 x 1,5	0 168 700 22

Other end stops: See Accessories section
Other rails: See Accessories section
Other accessories: See Accessories section

Type	P/N
Grey body	
M 4/6.CA I/U - 250	0 007 025 17

Type	P/N
Grey body	
M 4/6.CA I/U - 500	0 007 026 10

Characteristics

Resistor	250 Ω	500 Ω
Rated power	0.35 W	0.35 W
Accuracy	0,1 %	0,1 %
Stability	25 ppm	25 ppm
	Resistor sized to give 5 V output at 20 mA.	Resistor sized to give 10 V output at 20 mA.

Characteristics

		NFC	DIN	UL	CSA	NFC	DIN	UL	CSA
Wire size (see generalities)	Solid wire	0,2-4 mm²				0,2-4 mm²			
	Stranded wire	0,22-4 mm²				0,22-4 mm²			
Rated voltage	V ⎓ ~								
Rated current	A	26				26			
Rated wire size		4 mm²				4 mm²			

Other Characteristics

Wire stripping length	Dia. Ø Screwdriver	Recommended torque	Protection
8,5 mm .33"	4 mm	0,4-0,6 Nm 3.5-5.3 lb.in	IP 20 NEMA 1

Wire stripping length	Dia. Ø Screwdriver	Recommended torque	Protection
8,5 mm .33"	4 mm	0,4-0,6 Nm 3.5-5.3 lb.in	IP 20 NEMA 1

Accessories

			Type		P/N
6	End section	grey	FEM6D	th. 1 mm	0 118 499 23
7	Separator end section	grey	SCF6D	th. 1 mm	0 118 495 17
8	Test device		DCG	grey	0 163 218 05
9	Test plug		FC2	Ø 2 mm	0 007 865 26
10	Comb type jumper bar		PC61	10 poles	0 163 311 22
11	IDC jumper		AD2,5		0 114 205 20
R	See section on markers				

			Typ		Best-Nr.
6	End section	grey	FEM6D	th. 1 mm	0 118 499 23
7	Separator end section	grey	SCF6D	th. 1 mm	0 118 495 17
8	Test device		DCG		0 163 218 05
9	Test plug		FC2	Ø 2 mm	0 007 865 26
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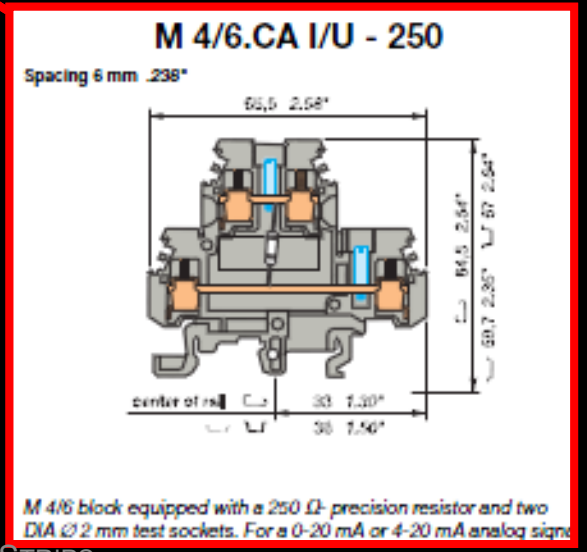
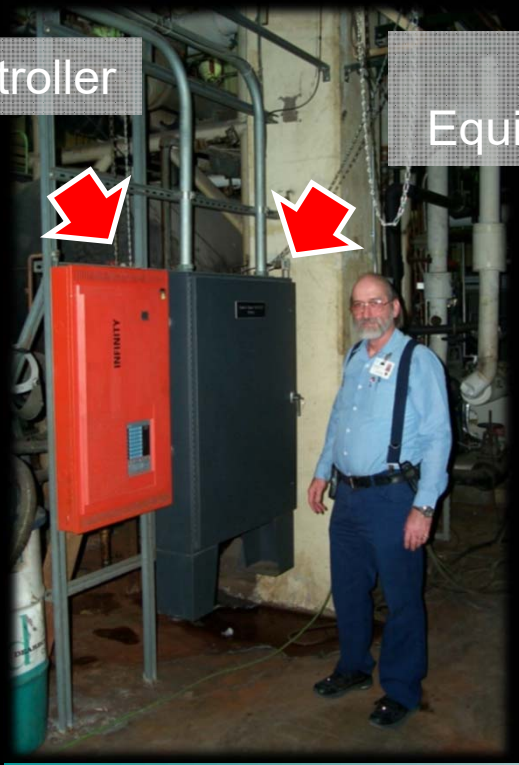
819

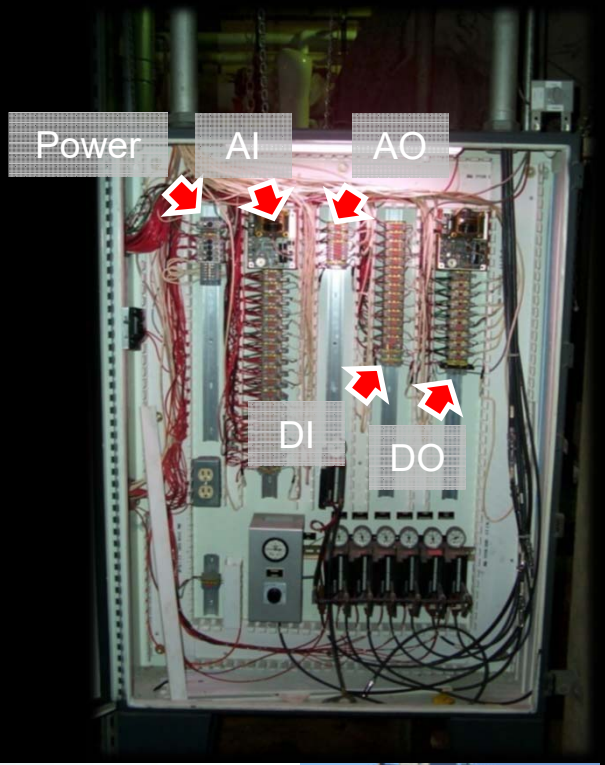


Similar products available from:

- Phoenix
- Allen Bradley
- Weidmuller

Applied on a Project in Carbondale, IL





MEMORIAL HOSPTIAL OF CARBONDALE

Applied on a Project in St. Louis, MO

Washington University in St.Louis • School of Medicine

Applied on a Project in St. Louis, MO

Washington University in St. Louis • School of Medicine

Inputs and Outputs – The Field Perspective

Tab 4-6 Supplement

Details on Specialized Terminal Strips

Presented By:
David Sellers, Senior Engineer
Facility Dynamics Engineering

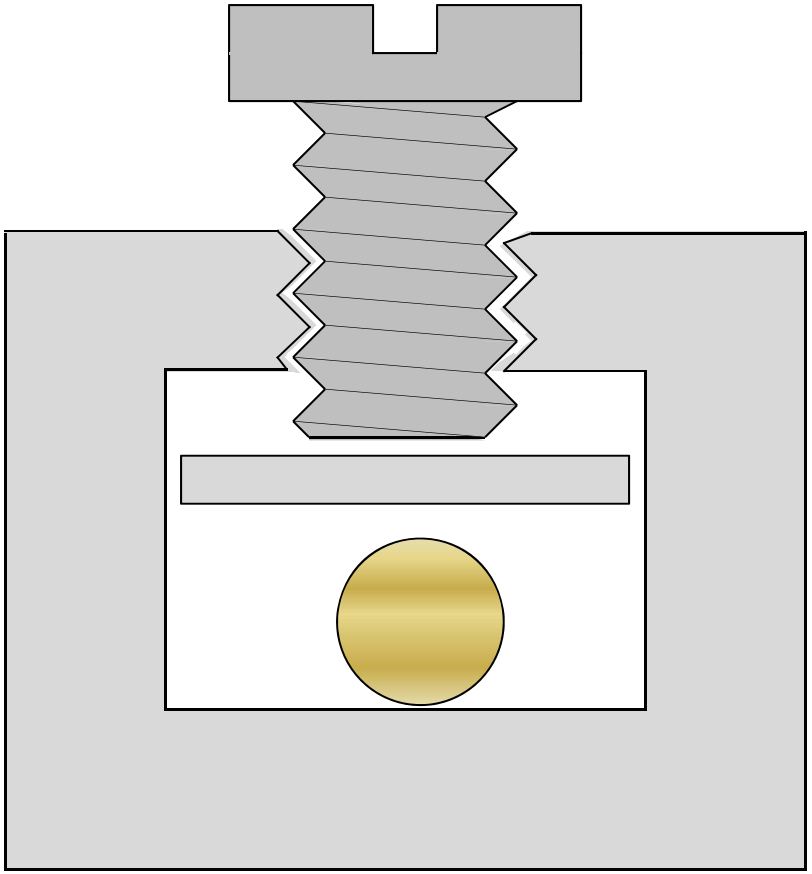
Facility Dynamics ENGINEERING

Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a solid conductor

- Conductor inserted between plate and tube

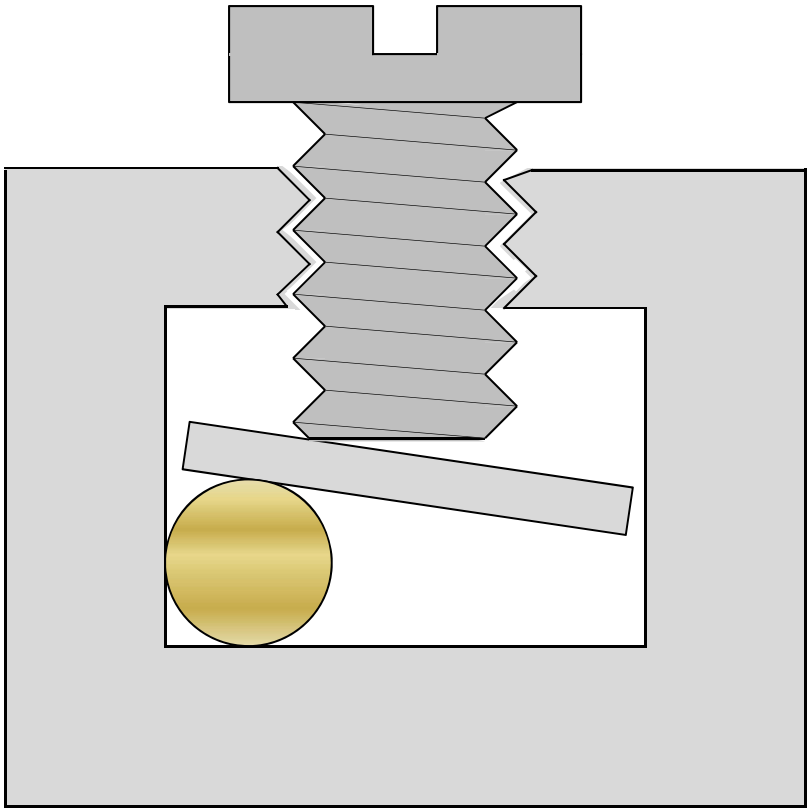


Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a solid conductor

- Conductor inserted between plate and tube
- Tightening the screw tends to clamp the conductor between a corner of the contact tube and the plate until the screw can no longer compress the conductor

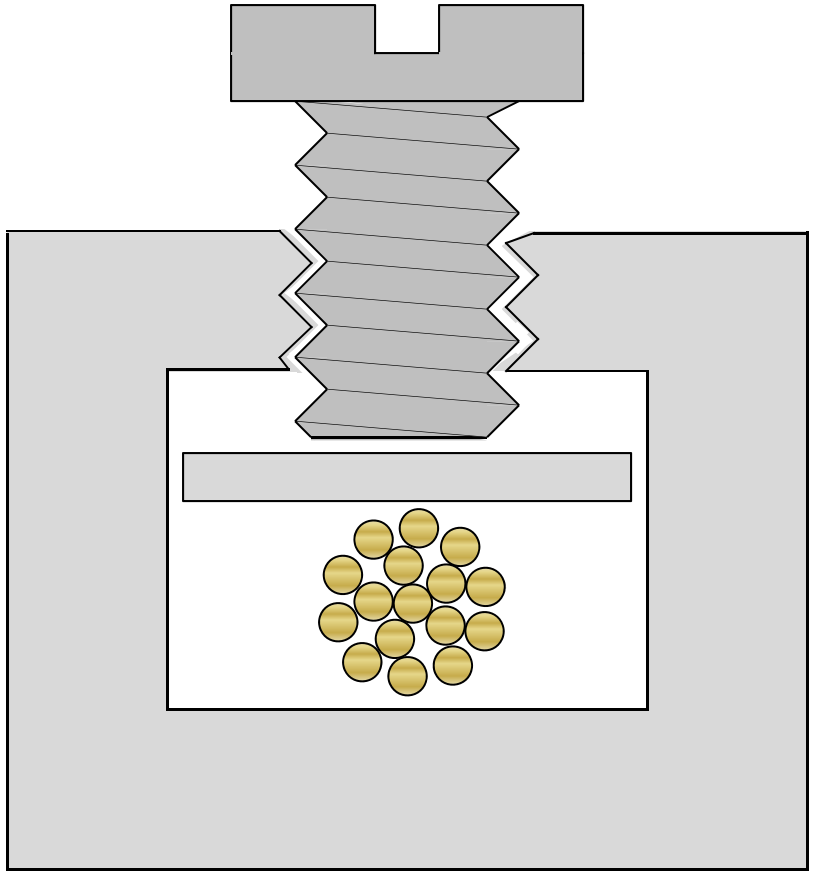


Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a stranded conductor

- Conductor inserted between plate and tube

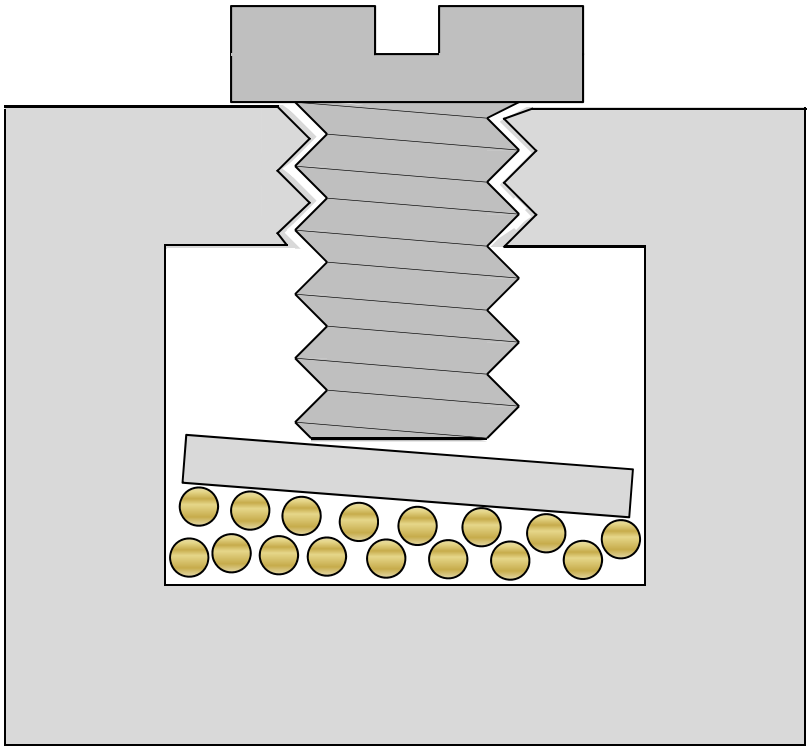


Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a stranded conductor

- Conductor inserted between plate and tube
- Tightening the screw tends to distort the bundle, spreading the strands out until they fill the space between the plate and contact tube and the plate can no longer compress them

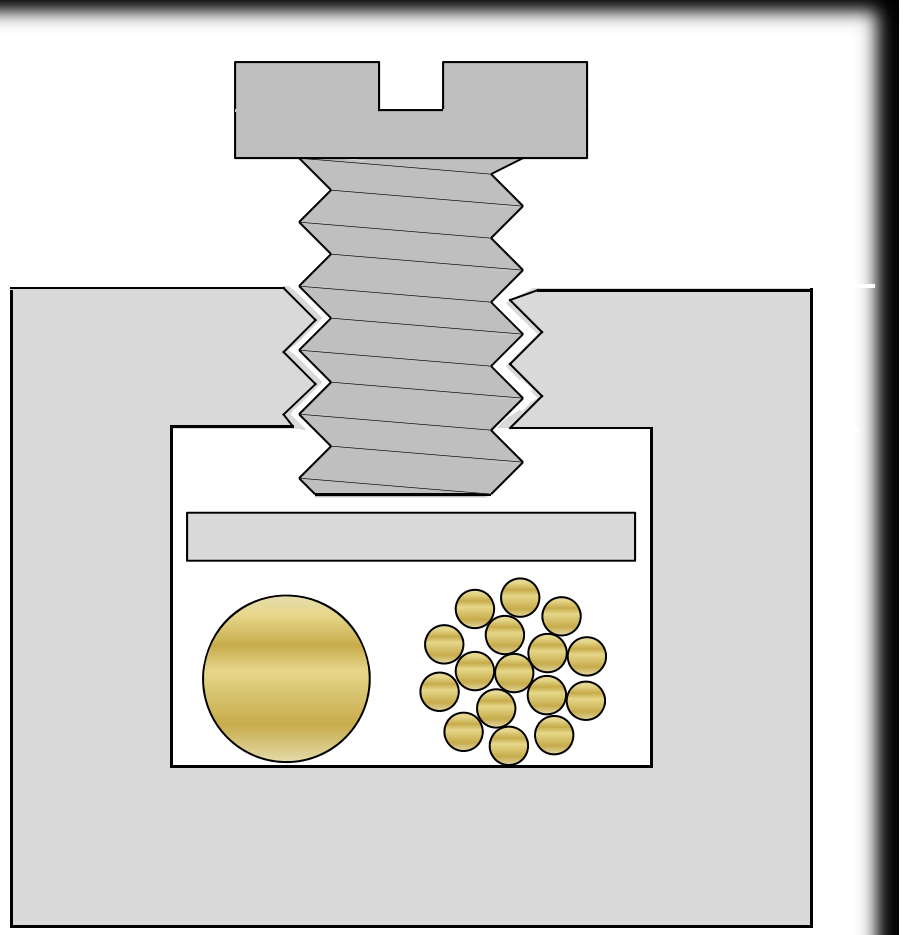


Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a solid with a stranded conductor

- Conductors inserted between plate and tube



Tubular Screw Clamp Terminals

Plate free to float between screw and tube

Clamping a solid conductor

- Conductor inserted between plate and tube
- When tightened, the screw tends to bottom out on the solid conductor and some of the strands, leaving other strands loosely gripped between the plate and the contact tube