

Caltrans' Controller Cabinet Standards

Models 33x, 33xL and 34xLX
Present and Future

GUEST SPEAKER

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Scope of Presentation

- Caltrans' 1989 Standard Cabinets
- L Cabinets TEES 2009
- LX Cabinets TEES 2009 Errata No. 2

Caltrans Cabinet Standards

THE MODEL SERIES

332, 334 & 336



Traffic Signal Control Equipment Specifications (TSCES) 1989

The Caltrans Controller Cabinet Standard is...

- Safe cabinet with 5 conditions for flash
- Manual and external flash reset
- Parallel I/O cabinet design
- 8-phase, 4-pedestrian operation (2 right-turn overlaps available)
- 36 detector channel capability (3 per left-turn, 6 per through movement)
- 2-channel or 4-channel industry standard detection modules
- Service required, single phase, 120 V



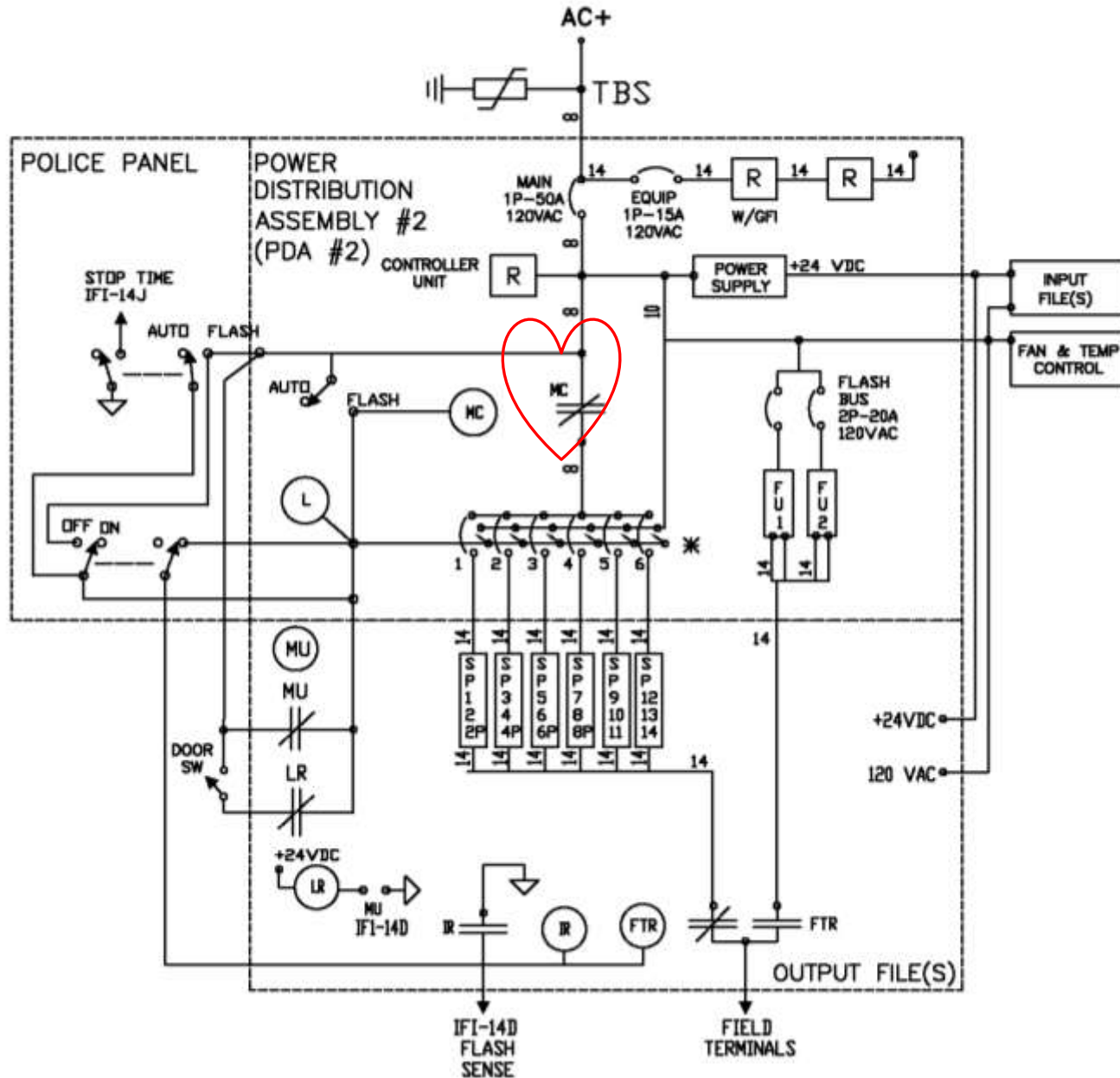
Cabinet Key Components

- Housing 1B
- 19" rack
- Mercury contactor
- Input files I and J
- Power Distribution Assembly (PDA)
- Output file
- Model 206 Power Supply
- Model 210 Conflict Monitor
- Houses a Model 170 or Model 2070 Controller



332 CABINET ONE LINE DIAGRAM

TSCS 1989



PDA Front



PDA Back



Output File Back



Issues with 1989 Design Spec

- 27-year-old specifications and design
- Designed for incandescent signal heads
- Assembly Bill AB 1415
 - Prohibits the use of Mercury Contactors after January 2006
- California Department of Toxic Substances Control (DTSC) exempts Caltrans and McCain until July 1, 2009



Issues with 1989 Design Spec Continue

- One vendor on Caltrans' QPL
- ITS Cabinet not ready
- NEC and other obsolescence issues
- Lacking BBS Standard Interface
- Not in TEES



L Cabinets TEES 2009

THE L SERIES CABINETS

332L, 334L & 336L



L Cabinet Key Differentiators

- Drawer shelf for laptop support and storage
- PDA xL
- Model 206L Power Supply
- SPA
- SSR
- Standard BBS Interface
- HI relay
- K24 relay



L Cabinet Function Differentiators

- L's green design reduces energy consumption through the use of a power-saving, high-efficiency power supply and eliminates the use of the harmful toxic mercury.
- Energy Saving-Switch-Mode Power Supply (SMPS), Model 206L
- Raw and Clean Power Circuits
- Service Panel Assembly (SPA) with replaceable surge suppressor
- Reduced circuit capacity for LED Signal Heads
- SSR Failure Indicator Circuit



Model 206L Power Efficiency

LOAD	Model 206	Model 206L
	Efficiency (η)	
1 Amp	43 %	75 %
2.5 Amp	60 %	84 %
5 Amp	69 %	86 %

Power Savings Calculations

$$P_d = P_{out} (1/\eta - 1) \quad @ \eta = 60\% \text{ for Model 206}$$

$$P_d = 60 (1/0.60 - 1)$$

$$P_d = 40 \text{ Watts}$$

$$@\eta = 84\% \text{ for Model 206L}$$

$$P_d = 60 (1/0.84 - 1)$$

$$P_d = 11.43 \text{ Watts}$$

$$P_{savings} = 40 - 11.43 = 28.57 \text{ Watts}$$

$$P_{savings} \text{ in kWh per Year } 28.57 \times 24 \times 365 = 250\text{kWh}$$



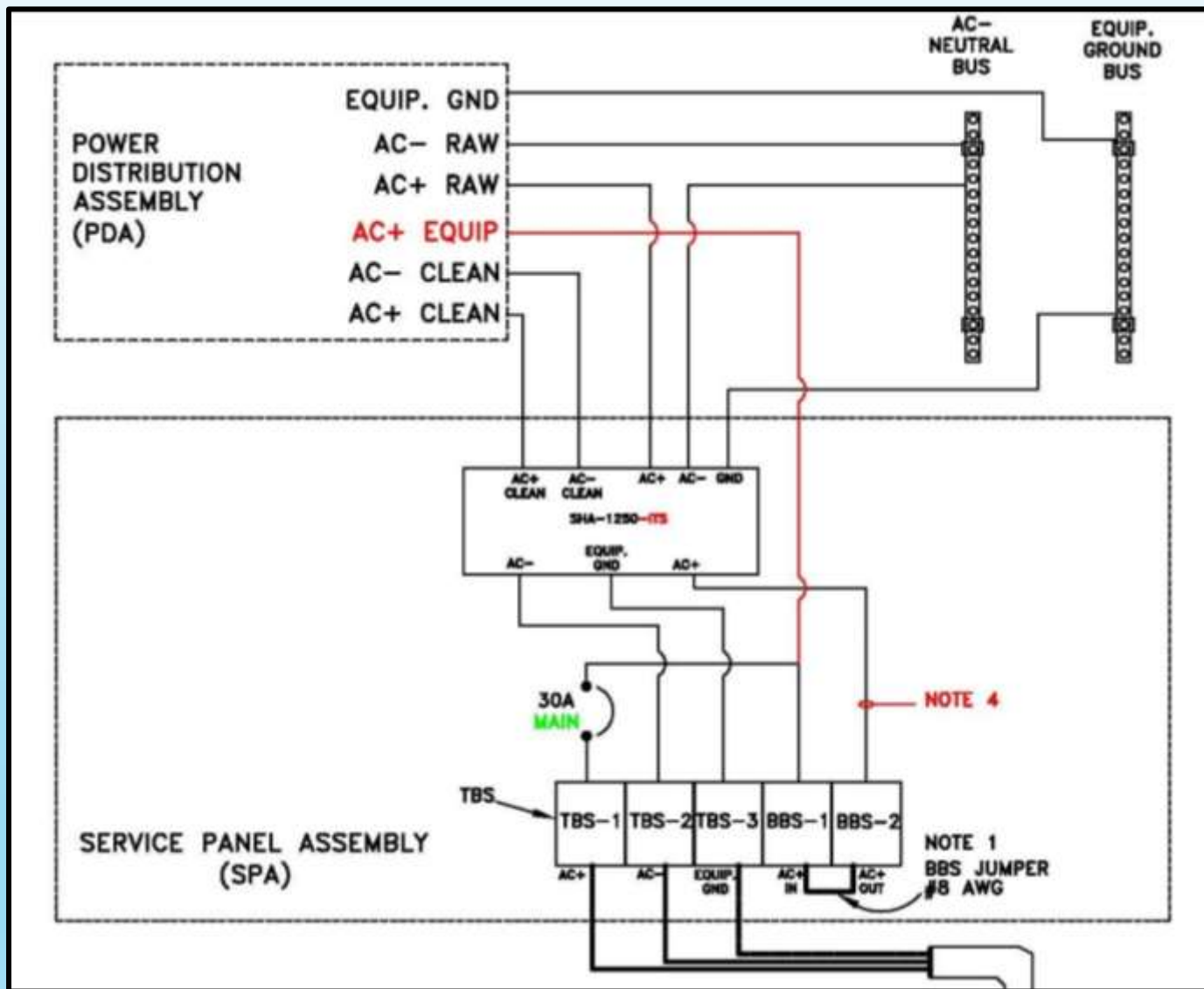
Caltrans Yearly Energy Savings

- At 50% load, the Model 206L will save 250kWh per year per cabinet.
- With a typical energy cost at \$0.10 /kWh, resulting a typical savings \$25 per cabinet annually, when compared to the Model 206.
- With half of the 10,000 locations using the L Cabinet, it would amount to a savings of \$ 25x 5000 = **\$125,000** per year



SPA Key Components

- Main Circuit Breaker
- Surge Suppressor and Filter
- BBS Standard Interface
- Provides the Clean and Raw Power Circuits



SPA



What is the purpose of the HE1750 or SHA-1250 filtering surge protector?

- The device provides clean power to sensitive electronic equipment:
 - 2070 Controller
 - Cabinet Power Supply
 - Input Assembly(s)
- It is rated for 15 amperes
- It is both a line filter and surge suppressor

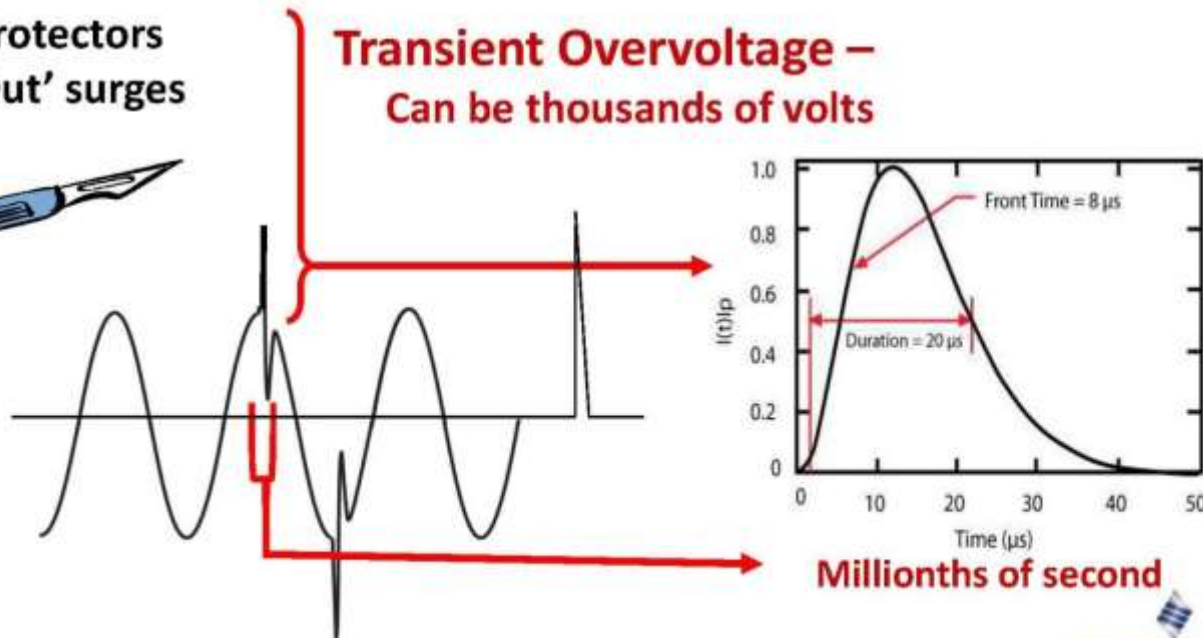
What Is a Surge/Transient?

- High amplitude, short duration overvoltage
- Can be positive or negative polarity
- Can be from energized or grounded conductor

Surge Protectors
'Chop Out' surges



Transient Overvoltage –
Can be thousands of volts



Millionths of second



When to
replace the
HE1750 or
SHA-1250
filtering
surge
protector?



Green On: Normal
Green Off: Replace
Yellow Off: Normal
Yellow On: Check

Green On: Normal
Green Off: Replace
Red Off: Normal
Red On: Check



AC+



SHEET DEFINITIONS

Cabinet Key Functionality

5 Conditions for Intersection FLASH		Causes
1	Manual Flash Mode by PDA Switch	Maintenance
2	Removal of MU and Door Close	Maintenance
3	Circuit Breaker Fails and Switch ON	CB fails
4	Manual Flash Mode via Police Panel (causes stop time)	Police
5	Flash Mode by MU	Model 206L fails
		Model 2070 WDT stops
		Green conflict
		Yellow conflict

PDA 2L



Meet the LX

CALTRANS LATEST CABINET STANDARD



LX Cabinet



LX Cabinets

TEES 2009 Errata #2

December 2014

THE LX SERIES

342LX, 344LX & 346LX



LX Series Assemblies

Product Differentiators



Model 210
Conflict Monitor



Model 206L
Power Supply



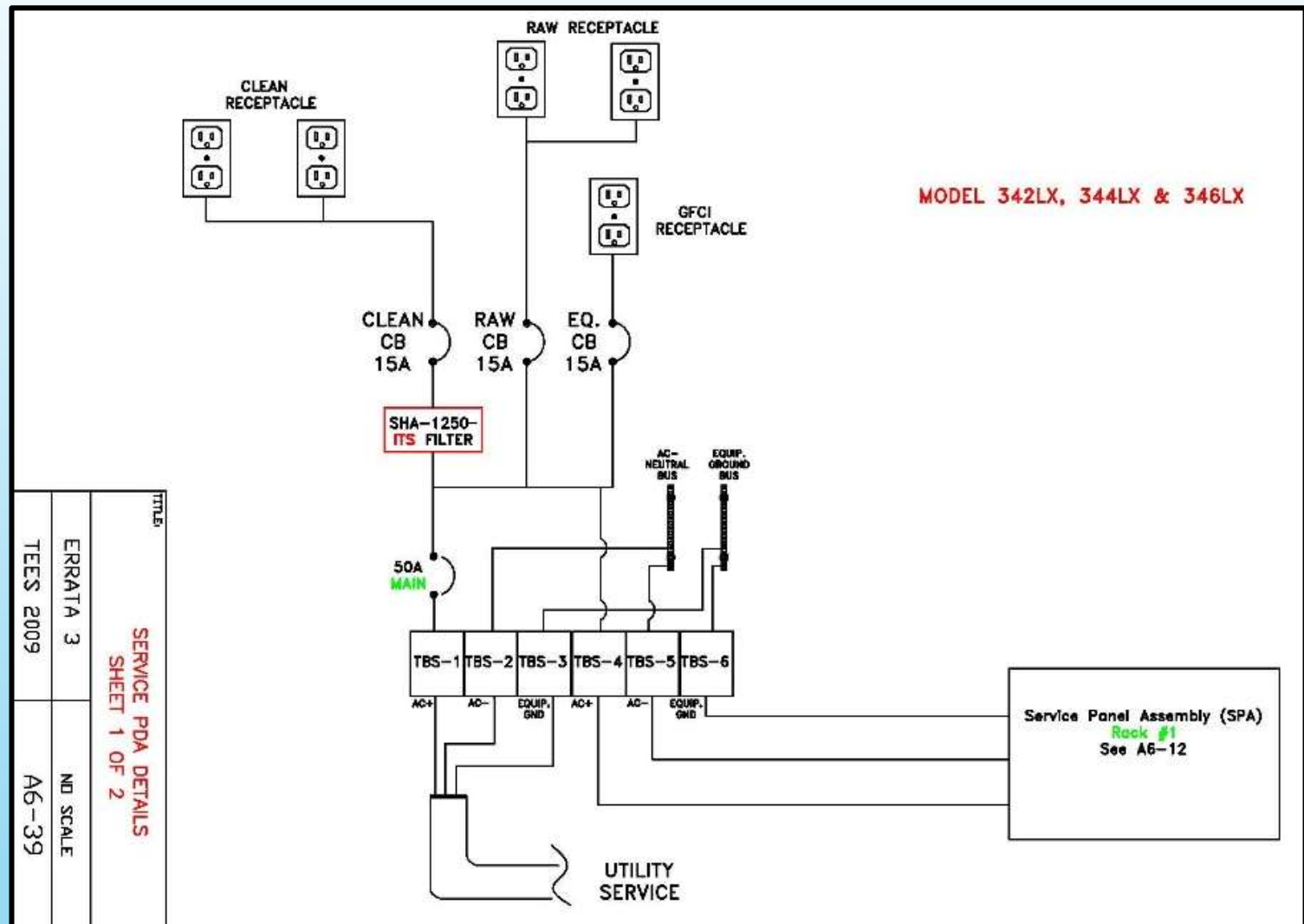
Model 764
Pre-Emption Unit



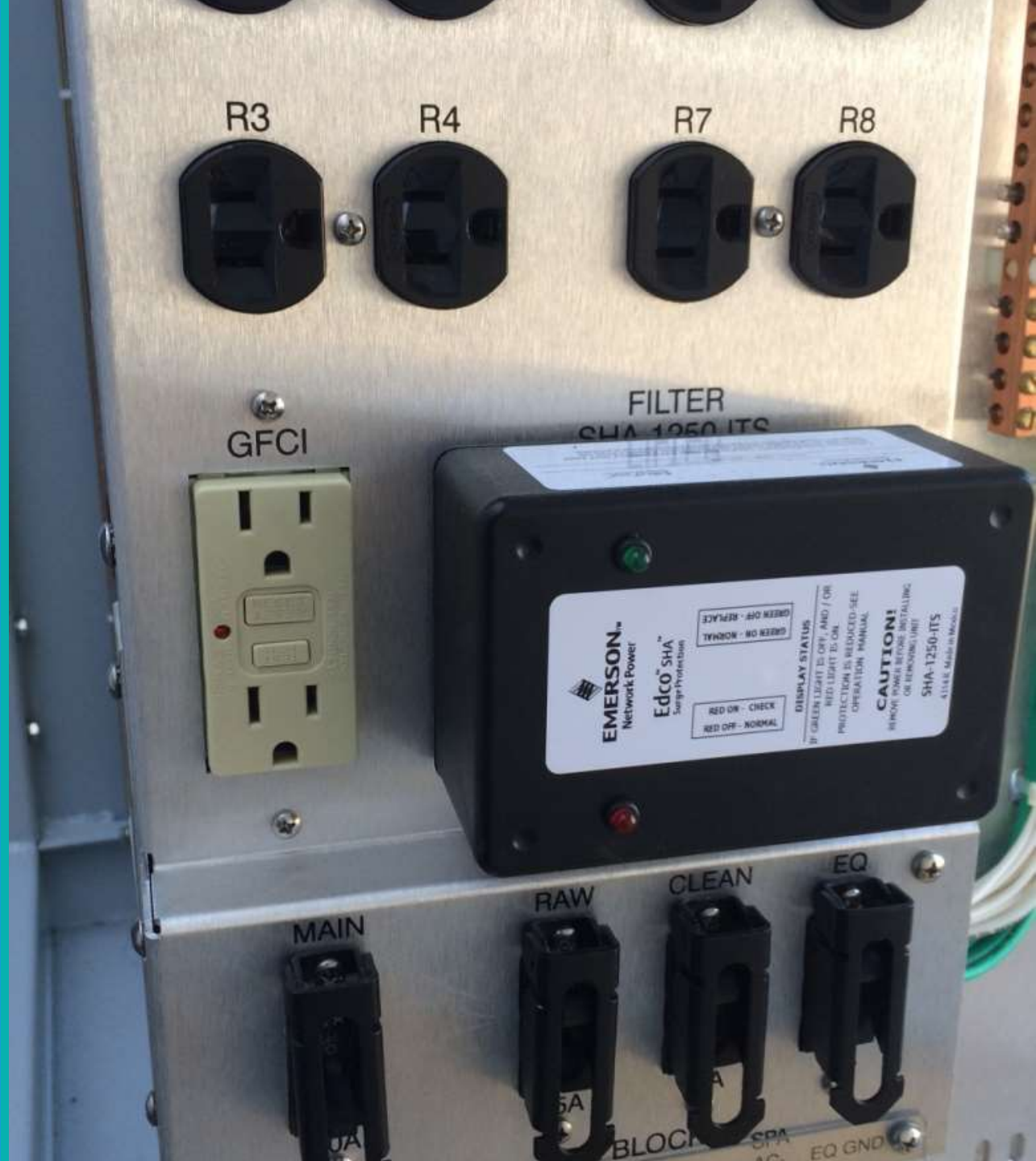
Model 242L
DC Isolator

LX Cabinet Key Differentiators

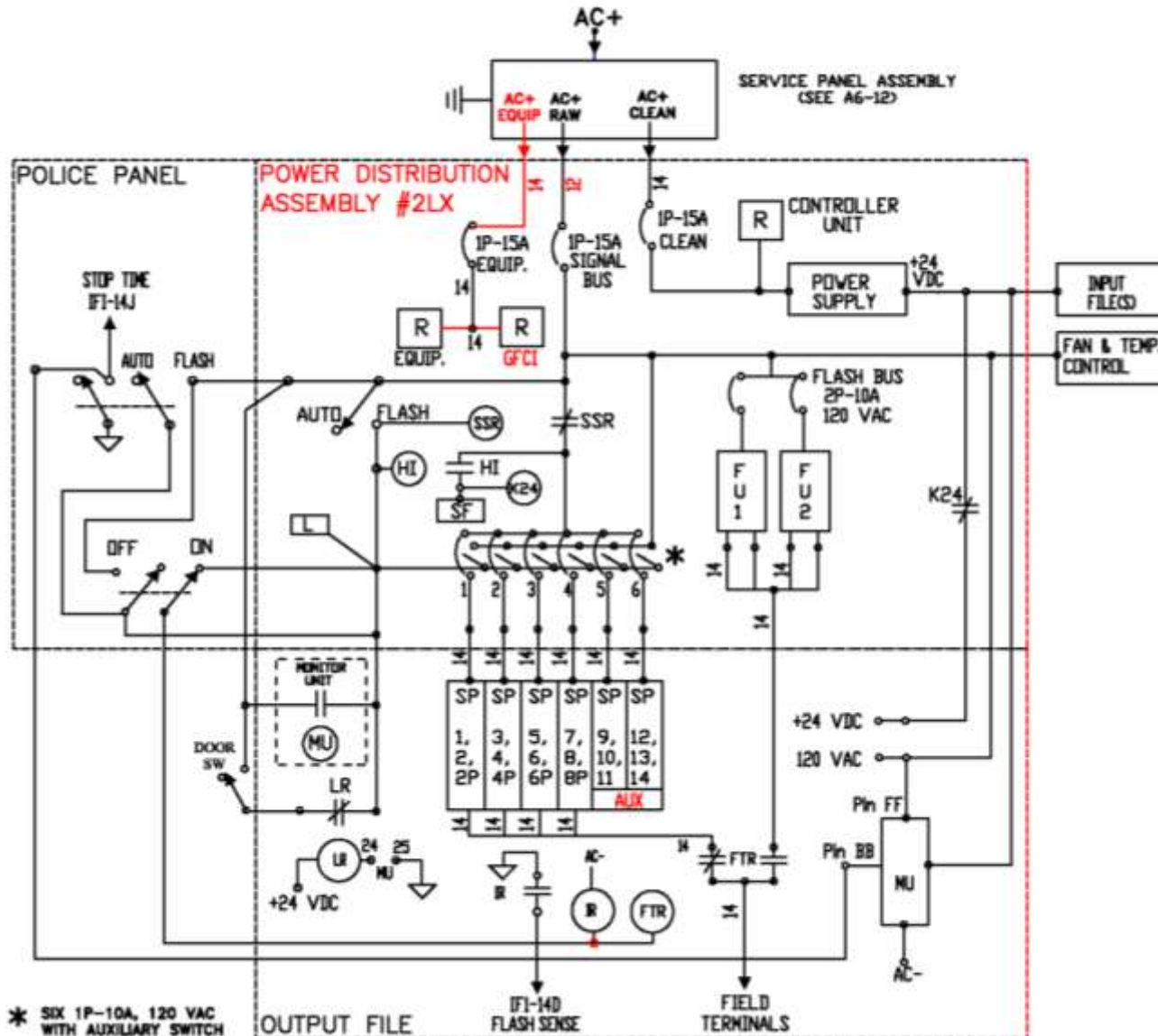
- Housing #3
- PDA LX; redesigned PDA to be touch safe
- Removal of 120 VAC from Input file
- Output file model LX; redesigned to be touch safe
- Integrated C11 harness for bicycle detection
- 4 fans
- LED lighting
- Two standard 19" racks
- Uses model 242L DC Isolator
- Service PDA
- Powder coated over aluminum with federal standard 595C, # 17178 color



LX Series Assemblies SPDA



342LX & 346LX CABINET ONE LINE DIAGRAM



PDA 2LX, Front



PDA 2LX, Back



Why LX Cabinets

- Users need for more rack space for traffic signal equipment
- Users need for more space for ITS equipment

Most Important: Personal Safety

- National Fire Protection Association (NFPA) 70E and need for a Touch Safe Cabinet.



Features & Benefits

- Solid state relay (SSR) (Mercury Contactor replacement)
- SSR Fault Indicator Light
- Relay safety feature interrupts 24 VDC control to the load switches if the SSR fails during a flash condition
- Programmable “Yellow/Red” or “All Red” flashes through the use of flash plugs
- DC isolation inputs for pedestrian push buttons and special functions
- 210/2010 signal monitor slot
- Transient voltage & surge suppression filter
- Drawer / shelf combination
- C11 harness
- Lights, LED



Personal Safety

NFPA Rules & Regulations



NFPA 70 Requirements

- Guarding of the Live Parts (Article 110-27):
Live parts of electrical equipment operating at 50 volts or more shall be guarded against accidental contact....
- Arcing Parts (Article 110.18):
Parts of electrical equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed....



Personal Safety

OSHA Rules & Regulations



- Occupational Safety and Health Act (OSHA) has similar requirements to NFPA.
- Until now, current traffic standards did not address guarding of live and arcing parts:
 - NEMA
 - TSCES
 - ITS Cabinet Standard
 - TEES



Why 50 Volts?

The Technical Details

- 6 mA-16 mA is known as “let-go” current range for human body.

- Definitions:

Term	Abbreviation	Measurement
Resistance	R	Ohm
Voltage	V	Volt
Current	I	Ampere

- Resistance of human body

- $R(\text{total}) = R(\text{skin-in}) + R(\text{internal}) + R(\text{skin-out}) + R(\text{point of contact})$
- $R(\text{total}) = 1,000 + 300 + 1,000 + 3,000 = 5,300 \text{ Ohm}^*$

** The 5300 Ohm may vary depending on a person size, humidity, etc.*



Why 50 Volts?

More Technical Details

Ohm's Law: $I=V/R$

- For a 120 volt system:
 - $120 \text{ V} / (5300 \text{ Ohm}) = 0.022\text{A}$ or 22mA
- For a 50 volt system:
 - $50 \text{ V} / (5300 \text{ Ohm}) = 0.009\text{A}$ or 9mA
- **9 mA falls between 6 mA-16 mA “let-go” range.**

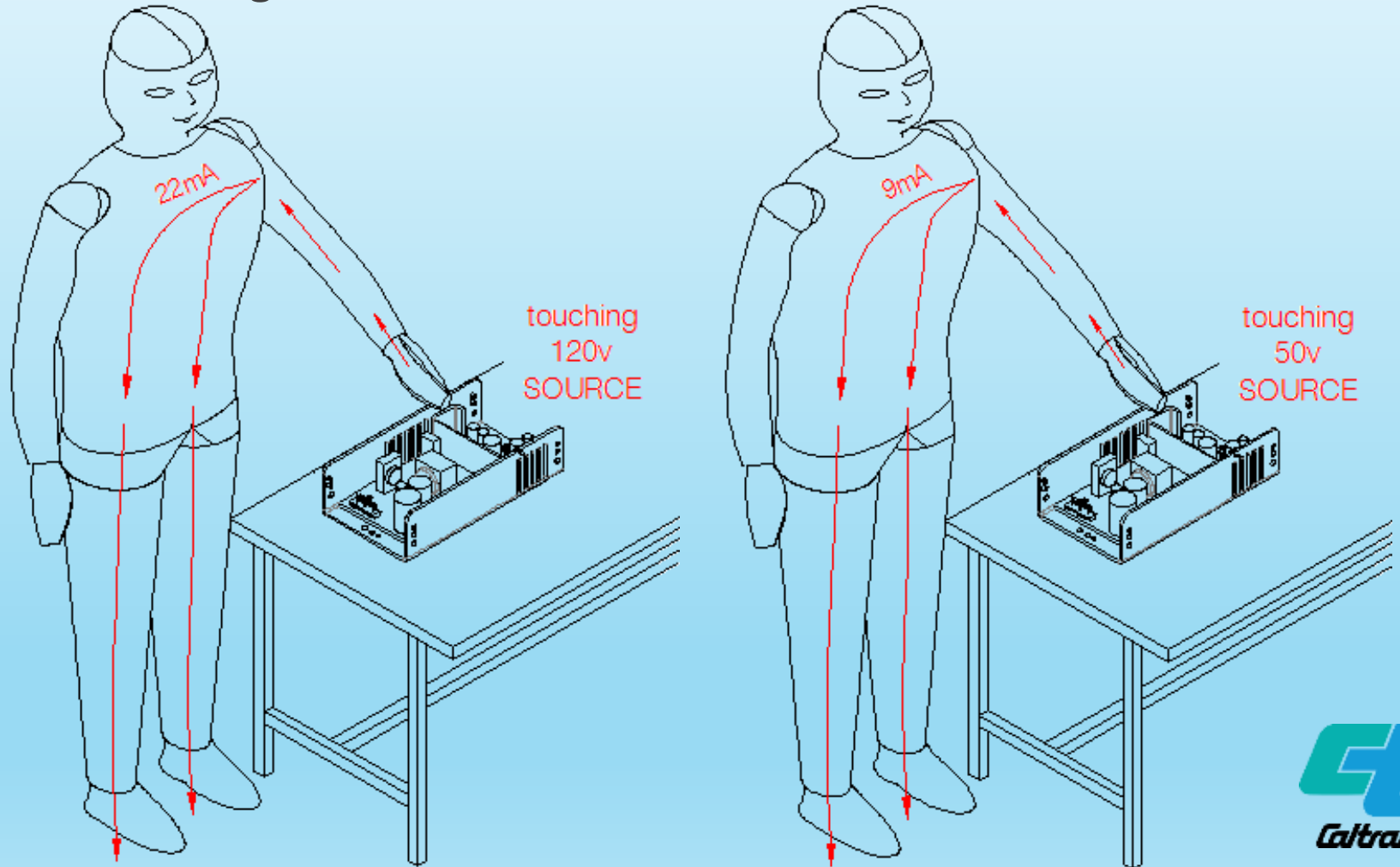
Types of Electrical Hazards

The relationship for a 60-cycle, hand-to-foot shock of one second duration:

Current Level	Probable Effect on Human Body
1 mA	Perception level. Slight tingling sensation. Still dangerous under <u>certain conditions</u> .
5 mA	Slight shock felt; not painful but disturbing. Average individual can let go. Strong <u>involuntary reactions to shocks in this range may lead to injuries</u> .
6 – 16 mA	Painful shock, begin to lose muscular control. Commonly referred to as the <u>freezing current or "let-go" range</u> .
17 – 19 mA	Extreme pain, respiratory arrest, severe <u>muscular contractions</u> . Individual cannot <u>let go</u> . <u>Death is possible</u> .
100 mA to 2 Amps	Ventricular fibrillation (uneven, uncoordinated pumping of the heart.) Muscular contraction and nerve damage begins to occur. <u>Death is likely</u> .
> 2 Amps	Cardiac arrest, internal organ damage, and severe burns. <u>Death is probable</u> .

Why 50 Volts?

So Basically... 9 mA Falls Between 6mA – 16 mA “Let-Go” Current Range



Solutions for Personal Safety

- Design and build equipment less than 50 volts
 - It would involve massive number of equipment manufacturers
 - While this may occur in near-term, it is not an immediate solution
- Provide Personal Protective Equipment (PPE) for all employees working with high voltage equipment
 - PPE is not cheap and requires continual training on proper use
- Design your cabinet assembly to guard against accidental contact and arc flash
 - The TEES 2009 Errata #2 LX Series Cabinet offers a solution



LX Series Assemblies

KEY PRODUCT DIFFERENTIATORS

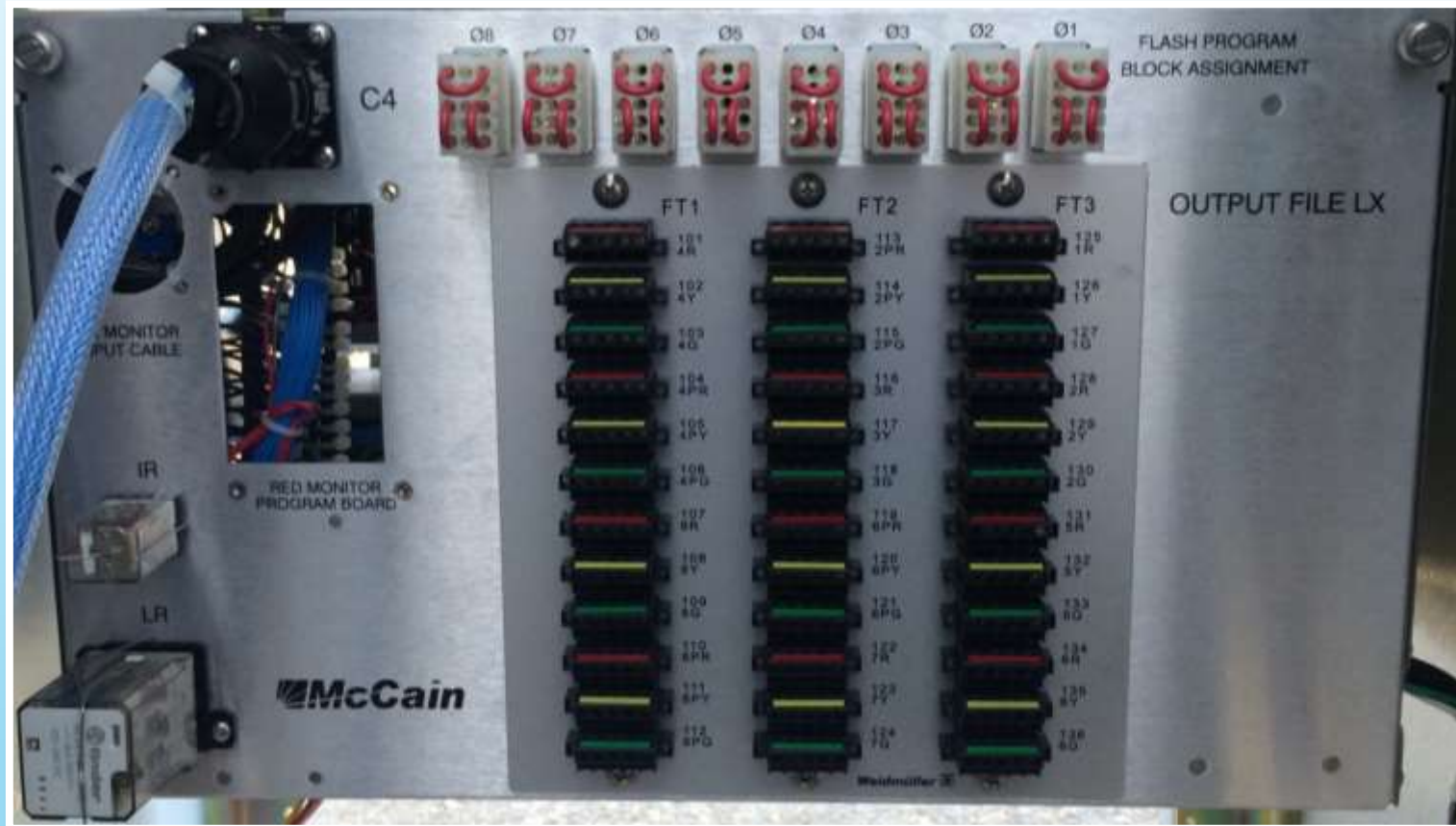


LX Series Assemblies

- Forward thinking – proactive approach
- Addresses NFPA 70E/ OSHA
- Continue to utilize the 170/2070 controller, firmware and standard plug-ins



Output File LX



LX in the Field

DEPLOYMENTS & AVAILABILITY



Current LX Cabinet Deployment

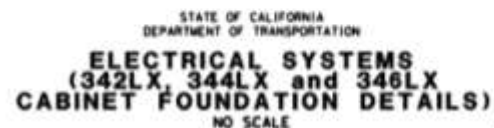
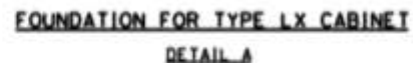
Cabinet Model	Caltrans District	QTY	Project	Date
342LX	12	50	I405 Improvement Project	2018
342LX	8	4	SR-91 Project RCTC	April 2016
344LX	10	11	Various	Early 2016

District 10 Fiber Deployment



†. Dimensions are nominal.

1. Dimensions are nominal.
2. For Model 342LX, 344LX and 346LX cabinets details, see "Transportation Electrical Equipment Specifications".
3. Grounding electrode shall be placed in front of the service conduit area.
4. Anchor bolts for Type LX cabinets shall be $\frac{1}{2}$ " ϕ x 1'-6" with a 2" - 90° bend.
5. Conduit area, to 120 V Service
6. Conduit area for the controller side of cabinet.
7. In sidewalks and other paved areas, top of foundation for Type LX cabinets shall be $3\frac{1}{2}$ " above surrounding grade.
8. An approved mastic or caulking compound shall be placed on the foundation prior to placing the cabinet to seal openings between bottom of cabinet and foundation.



ES-3LX

THE STATE OF CALIFORNIA BY ITS OFFICE OF
REVENUE SHALL NOT BE RESPONSIBLE FOR
THE ACCURACY OR COMPLETENESS OF STAMPED
COPIES OF THIS PLAN 00071.

201X STANDARD PLAN ES-3LX

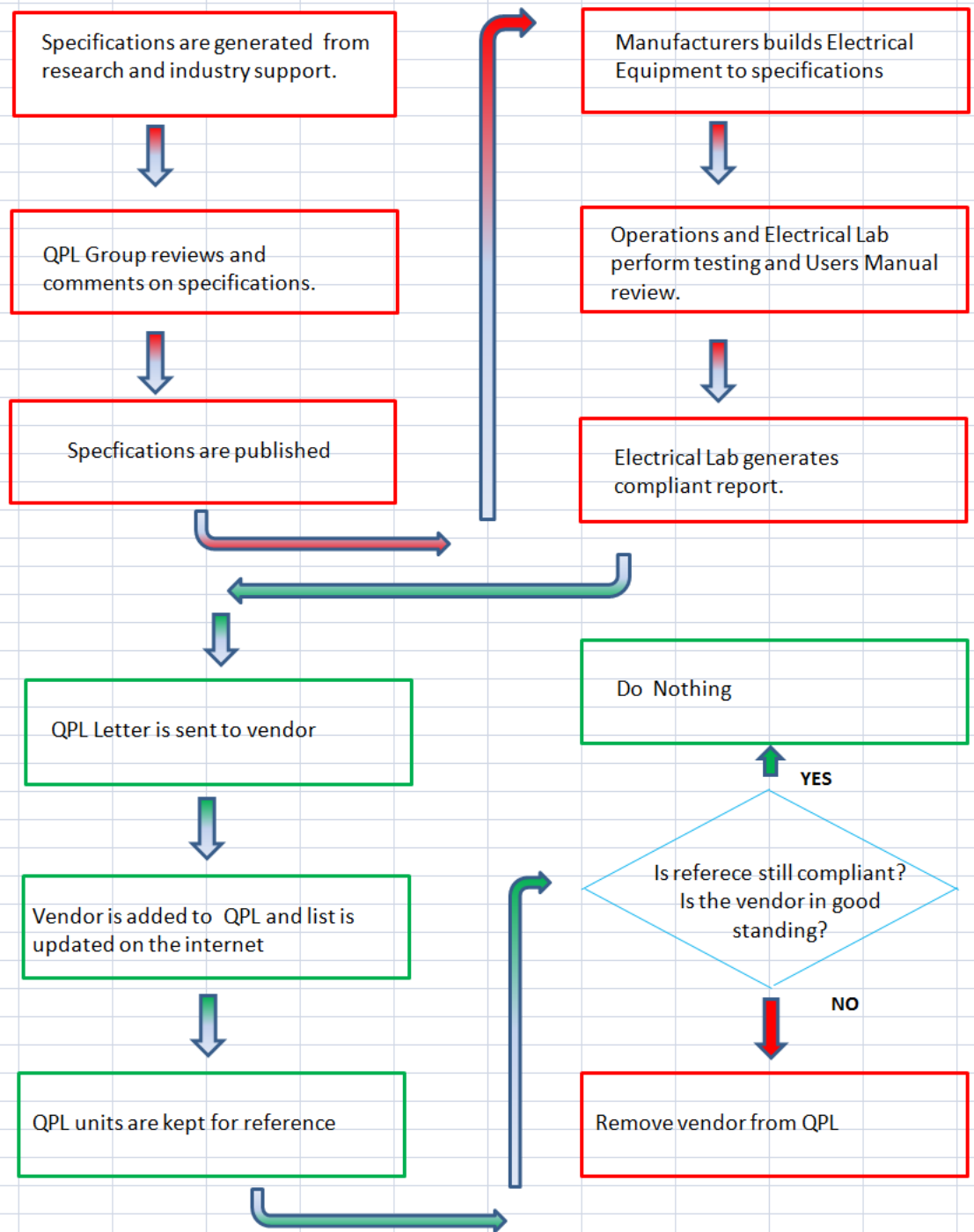
Master Purchase Agreement

Current MPA with McCain Traffic

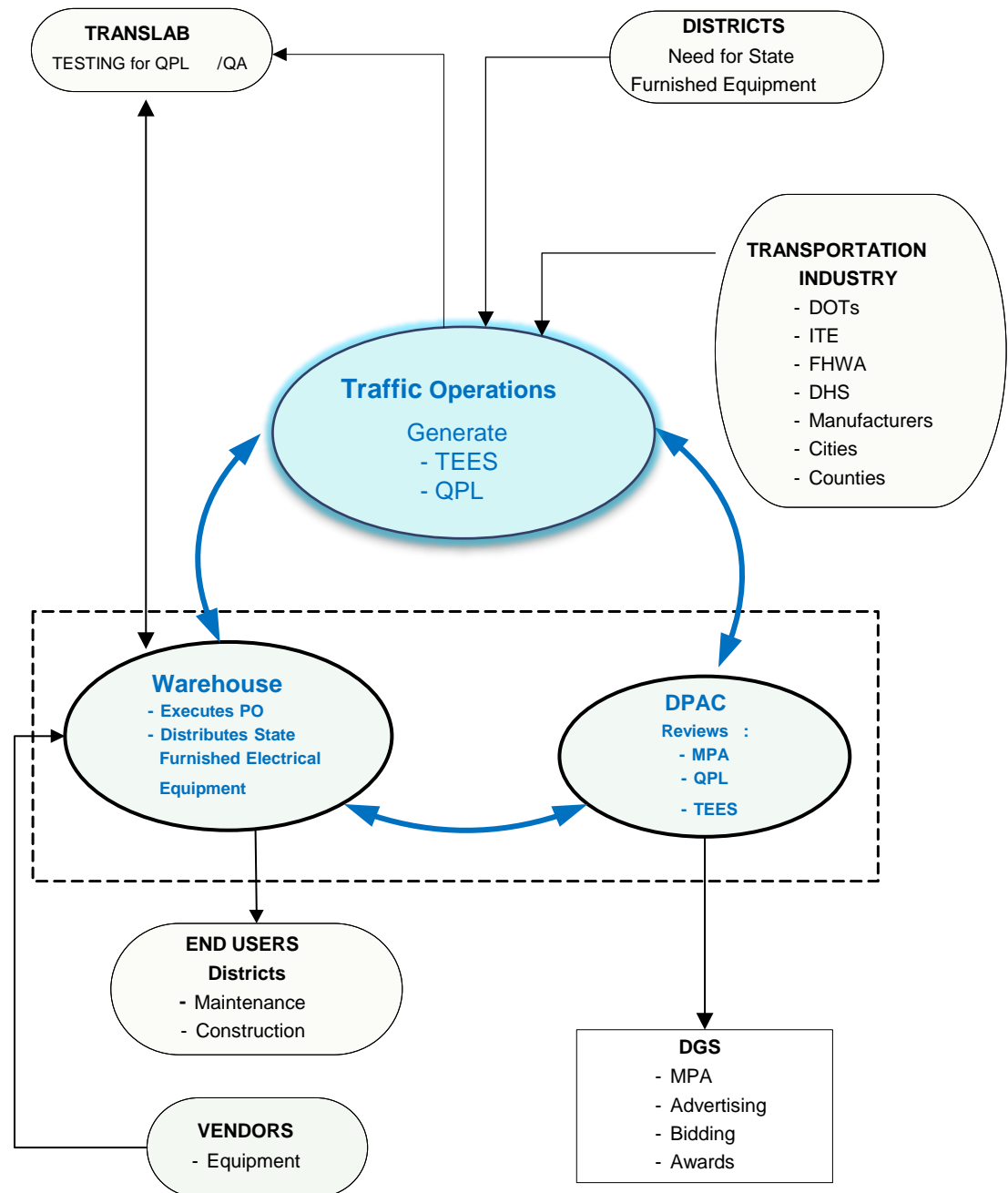
Cabinet	Price	LX vs L Price
Model 342LX	\$4214	\$348
Model 332L	\$3867	
Model 344LX	\$3640	\$743
Model 334L	\$2893	



QPL Process for State Furnished Material



Procurement Process for Electrical Equipment



Manufacturers

I really like the LX Cabinet! Who Makes it?



Recap

- The traffic signal cabinet standards and specifications do not cover the personal safety of the personnel. It has always been assumed that the people who have access to cabinets are qualified, trained and experienced.
- Other groups – such as the ITS group and consultants – may have access and may not have proper training or knowledge of the risk of working around high voltage equipment.
- The TEES 2009 Errata #2 LX Series Cabinet offers a solution.

Any Questions?

THANK YOU!



Acronyms

BBS	Battery Backup System
CB	Circuit Breaker
DC	Direct Current
DGS	Department of General Services
DHS	Department of Homeland Security
DOTs	Departments of Transportation other than Caltrans
DTSC	California Department of Toxic Substances Control
DPAC	Division of Procurement and Contracts
FTR	Flash Transfer Relay

FU 1	Flasher Unit Number 1
FWHA	Federal Highway Administration
GFCI	Ground Fault Circuit Interrupter
HI	Health Indicator Relay
I	Current
I/O	Input/ Output
IR	Isolation Relay
ITE	Institute of Transportation Engineers
ITS	Intelligent Transportation System
kWh	Kilo Watt Hour
L	Flash ON Indicator Lamp
LR	Logic Relay

MC	Mercury Contactor
MPA	Master Purchase Agreement
MU	Monitor Unit
mA	Milliamperes
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Act
PD	Power Dissipated
PDA	Power Distribution Assembly
PO	Purchase Order
PPE	Personal Protective Equipment

QA	Quality Assurance
QPL	Qualified Products List
SF	SSR Failure Indicator
SMPS	Switch-Mode Power Supply
SP 1	Switch Pack Number 1
SPA	Service Panel Assembly
SSR	Solid State Relay
TBS	Terminal Block-Service
TEES	Transportation Electrical Equipment Specifications
TSCES	Traffic Signal Control Equipment Specifications
V	Voltage
WDT	Watchdog Timer

Links of Interest and References

Transportation Electrical equipment Specifications (TEES)

- www.dot.ca.gov/trafficops/tech/tees.html

91 Project Fast Forward

- www.sr91project.info/design-build-schedule

Orange County Transportation Authority

- www.octa.nethttp://www.octa.net/Projects-and-Programs/All-Projects

Surge Protection 2015, Pete Ganci, BSET, Sales Engineer at Emerson

- www.aptsurge.com/salesindustrialspecialtyusa.aspx

McCain, Inc.

- www.mccain-inc.com

Safetran

- www.safetran-traffic.com

Eberle Design Inc. (EDI)

- www.editraffic.com

