IESALC Illuminating Engineering Society of North America Aviation Lighting Committee

DC POWERED LED TAXIWAY CENTERLINE LIGHTING SYSTEM: A CASE STUDY

Presented to:

IES ALC Fall Conference 2010

by:
Frank Barczak
Jeff Pace
Carl Johnson

GREATER ORLANDO AVIATION AUTHORITY

AVCON

AC

AC

AC

DC

6.6 AMP

DC

AC

2 AMP

DC

6.6 AMP

AC


WELCOME TO
Orlando
Huānyíng • Bienvenu • Willkommen • Velkominn • Yoi
Bienvenido • Welkom • Saudacão Amável • Benvenuto

ORLANDO INTERNATIONAL AIRPORT

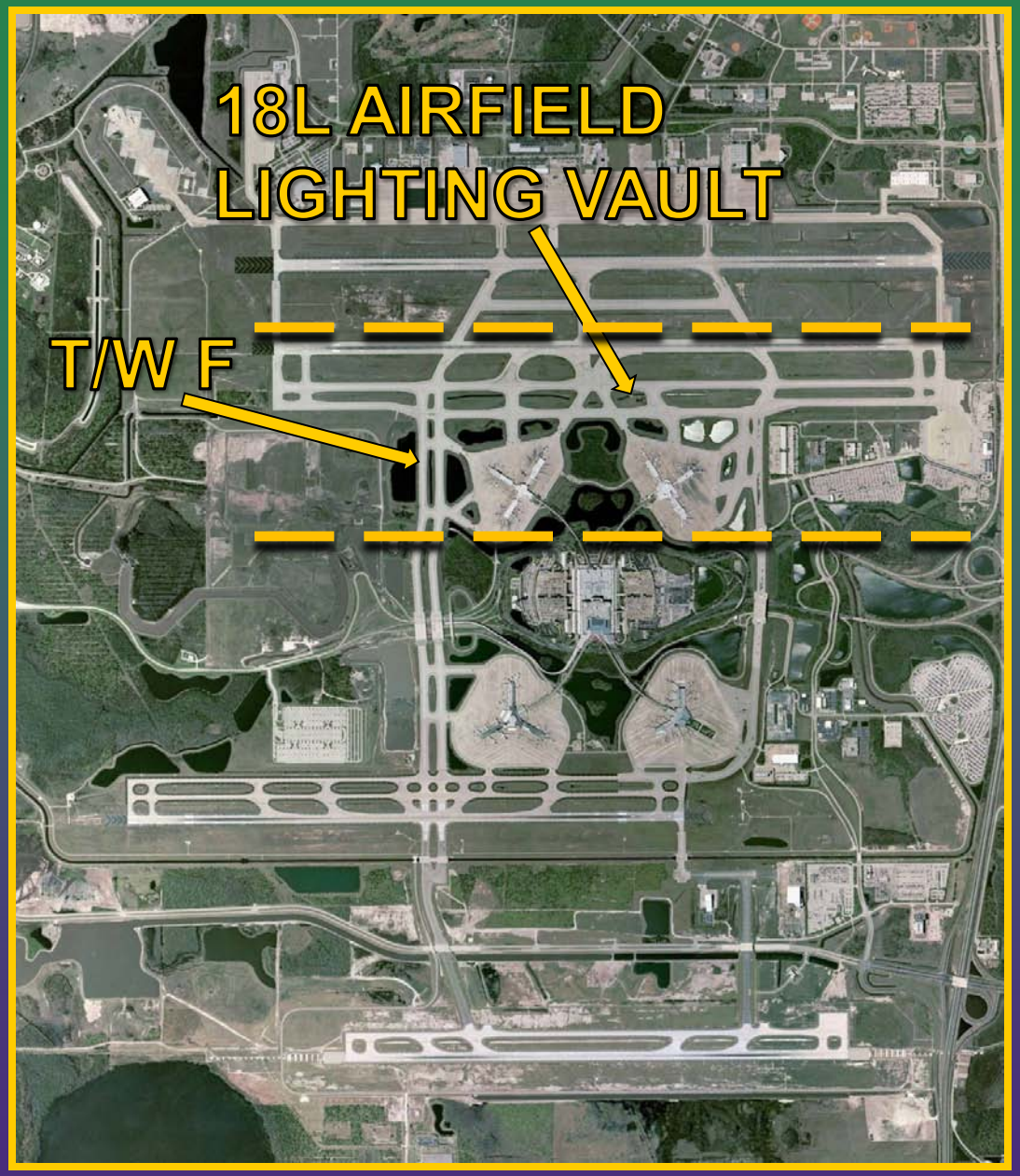
ORLANDO INTERNATIONAL AIRPORT IS THE BUSIEST AIRPORT IN FLORIDA IN TERMS OF PASSENGER TRAFFIC, WITH MORE THAN 35 MILLION TRAVELERS PER YEAR.

LOCATED IN SOUTH ORLANDO, THE AIRPORT IS SERVED BY MORE THAN 50 AIRLINES. WITH 13,297 ACRES, OIA IS THIRD LARGEST AIRPORT IN THE NATION IN TERMS OF SIZE.

ORLANDO INTERNATIONAL AIRPORT

IT HAS FOUR PARALLEL RUNWAYS; INCLUDING TWO THAT STRETCH 12,000 FEET AND CAN ACCOMMODATE THE LARGEST AIRCRAFT IN THE WORLD.

THE AIRFIELD CAN HANDLE 140 TAKEOFFS AND LANDING PER HOUR, WITH 90 ARRIVAL AND DEPARTURE GATES.



North

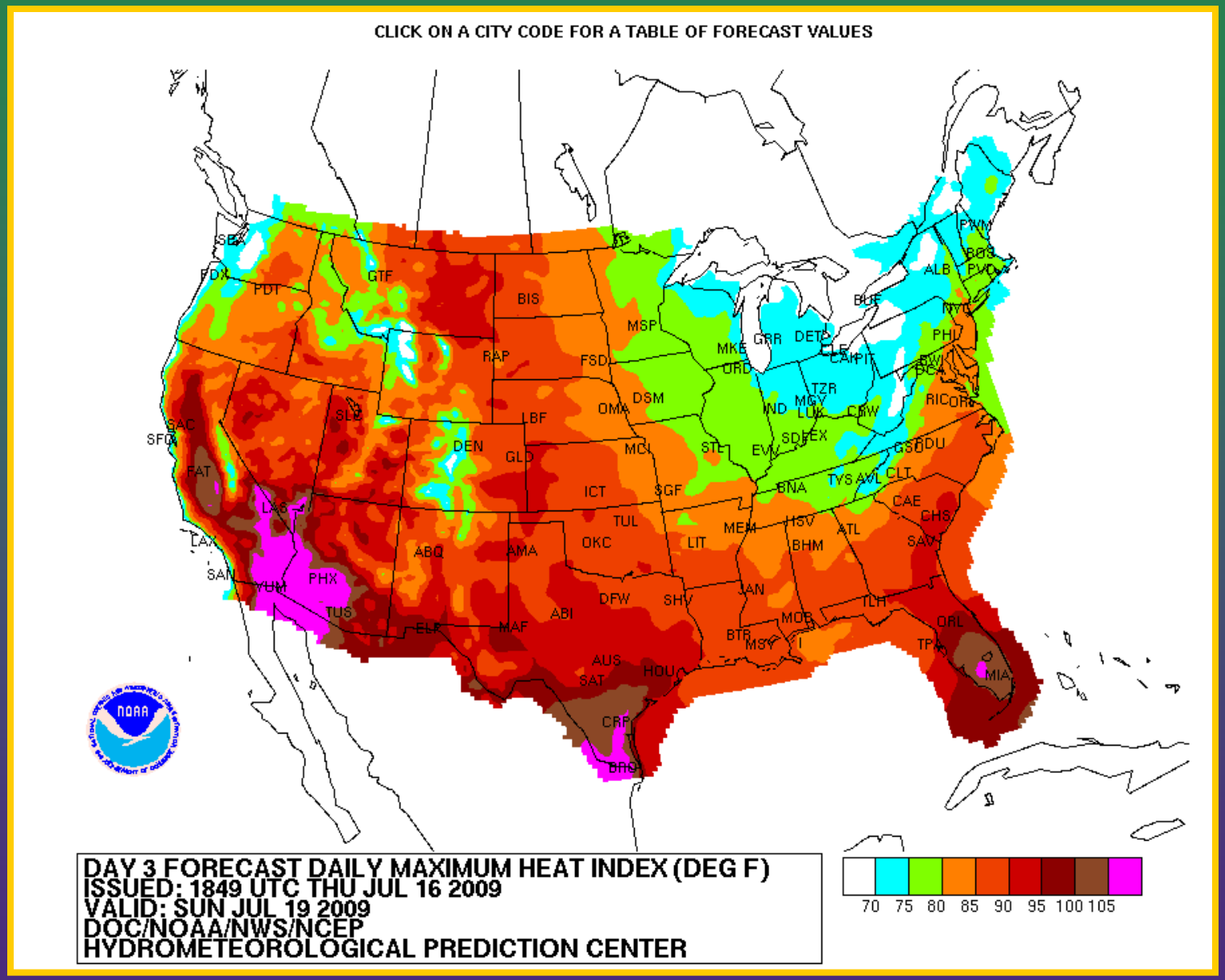
ORLANDO INTERNATIONAL AIRPORT


TAXIWAY "B"
TAXIWAY "C"
TAXIWAY "C"
TAXIWAY "B7"
North
ORLANDO INTERNATIONAL AIRPORT
T/W F
T/W "E1"
T/W "E1"
AIRSIDE 3
TAXIWAY "E"
TAXIWAY "F"
TAXIWAY "E2"
TAXIWAY "E3"
T/W "E2"

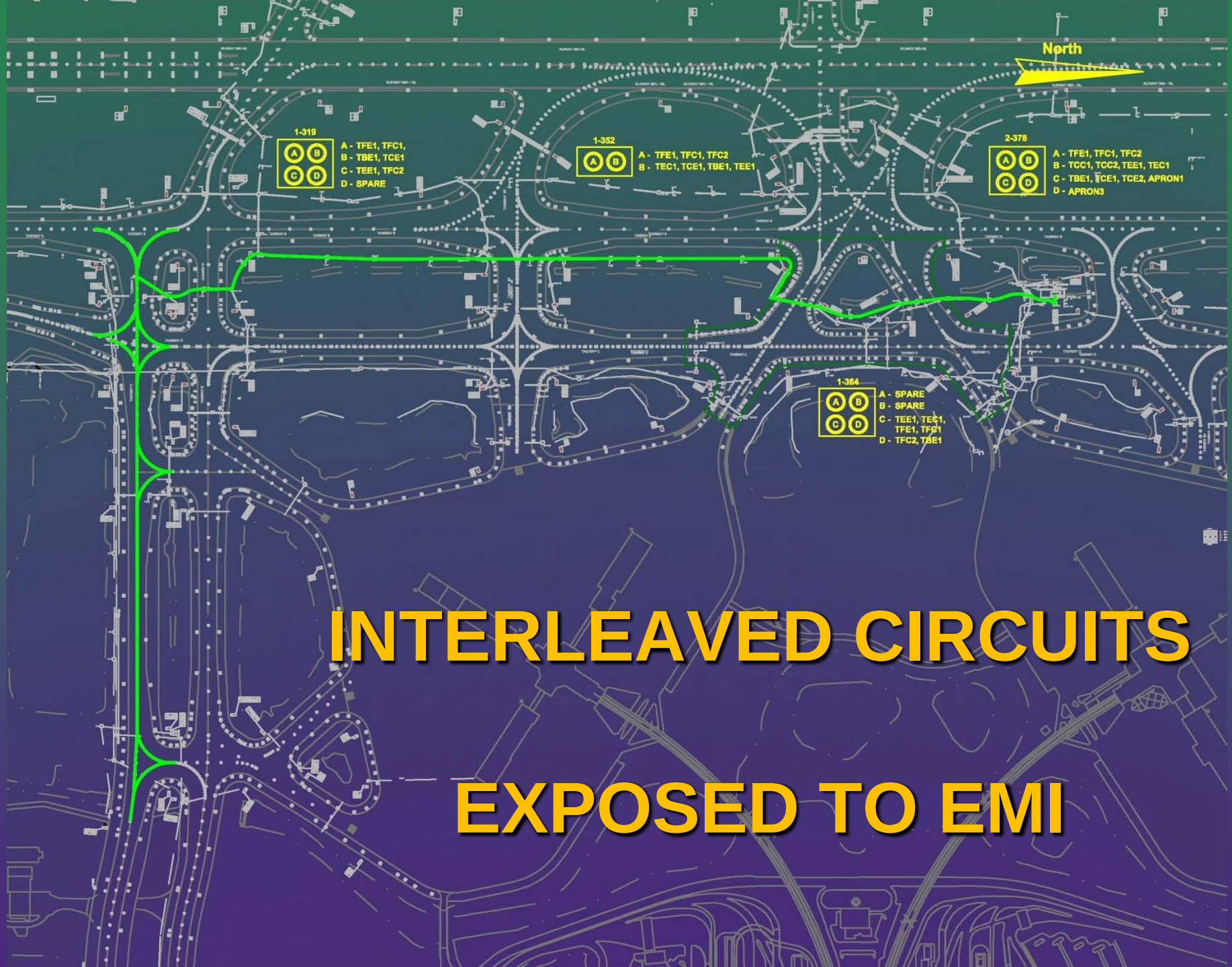
WHY OIA?

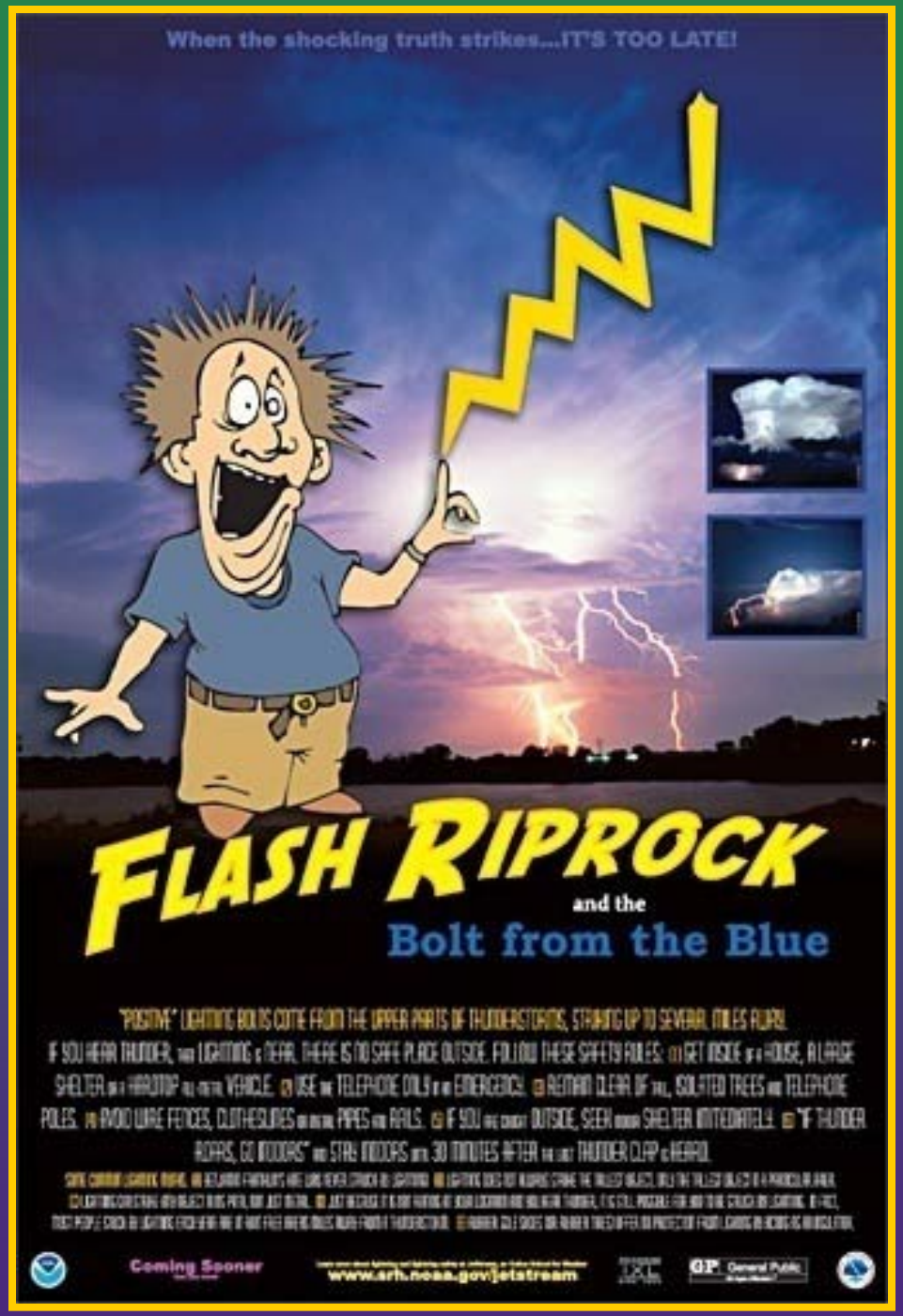
HIGH GROUND WATER

HIGH TEMPERATURES & HUMIDITY



HEAVY AIRCRAFT


North
1-319
A - TFE1, TFC1,
B - TBE1, TCE1
C - TEE1, TFC2
D - SPARE
1-352
A - TFE1, TFC1, TFC2
B - TEC1, TCE1, TBE1, TEE1
2-378
A - TFE1, TFC1, TFC2
B - TCC1, TCC2, TEE1, TEC1
C - TBE1, TCE1, TCE2, APRON1
D - APRON3
1-364
A - SPARE
B - SPARE
C - TEE1, TEC1,
TFE1, TFC1
D - TFC2, TBE1
INTERLEAVED CIRCUITS
EXPOSED TO EMI

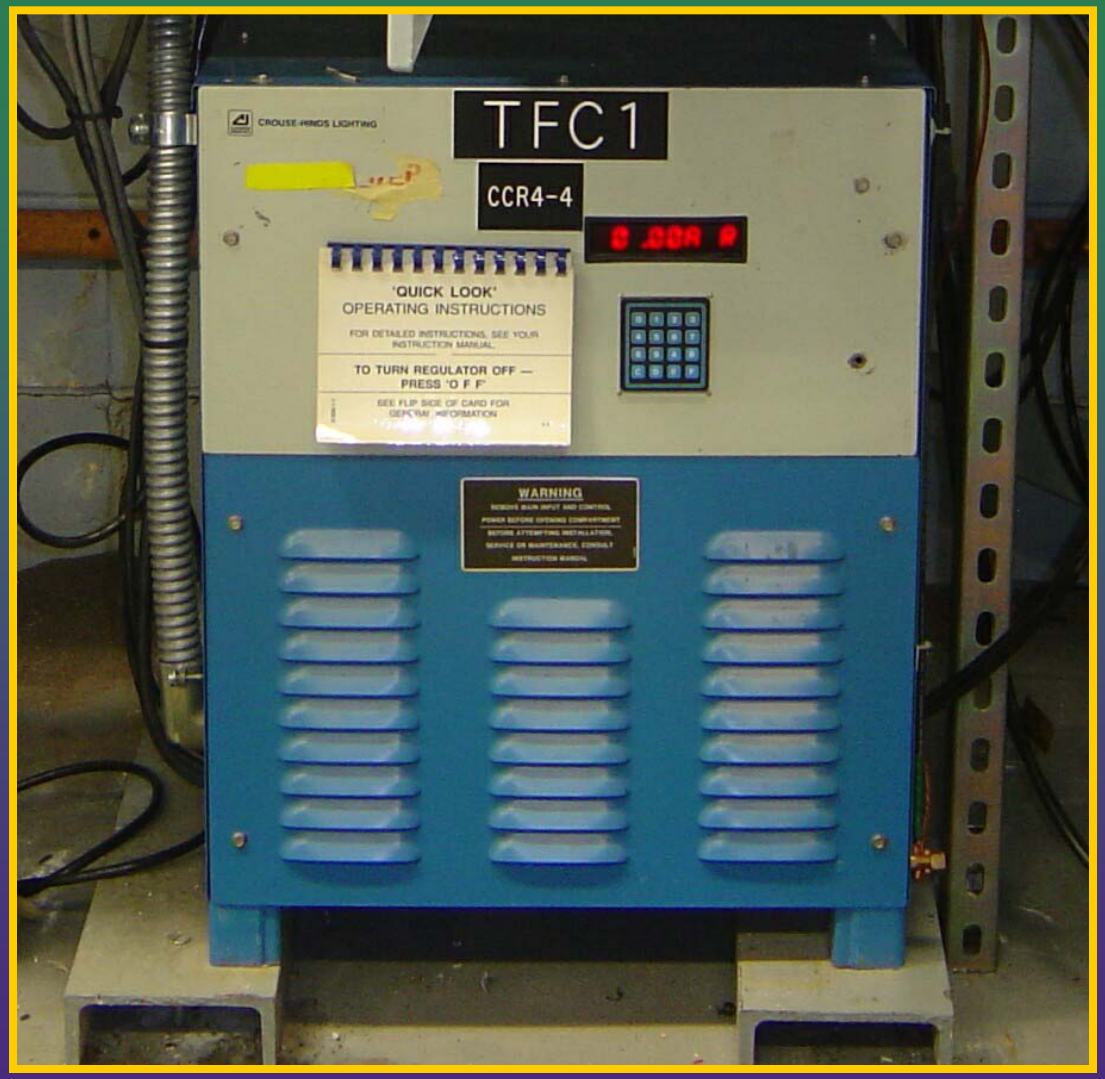

When the shocking truth strikes...IT'S TOO LATE!
FLASH RIPROCK
and the
Bolt from the Blue
Coming Sooner
www.srh.noaa.gov/jetstream
GP General Public

LIGHTNING

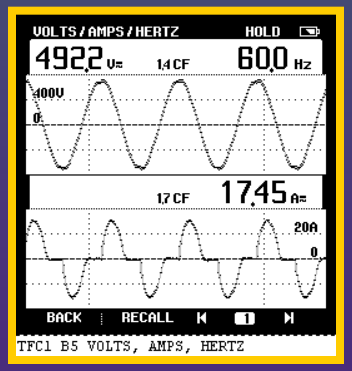
EXISTING CIRCUIT

- TFC1 CIRCUIT IS POWERED FROM THE 18L AIRFIELD LIGHTING VAULT.
- TFC1 CONSISTS OF 28 EACH L-852C LED FIXTURES AND 88 EACH L-852D LED FIXTURES AND INCLUDES 22,000 FEET OF L-824 5 KV CABLE.
- TFC1, WAS FIRST INSTALLED IN 1989 USING INCANDESCENT FIXTURES.
- TFC1, UPDATED IN 2005 USING LED FIXTURES.

EXISTING CIRCUIT



TFC1 WAS A STANDARD AIRFIELD LIGHTING CIRCUIT USING SCR TYPE CCR.

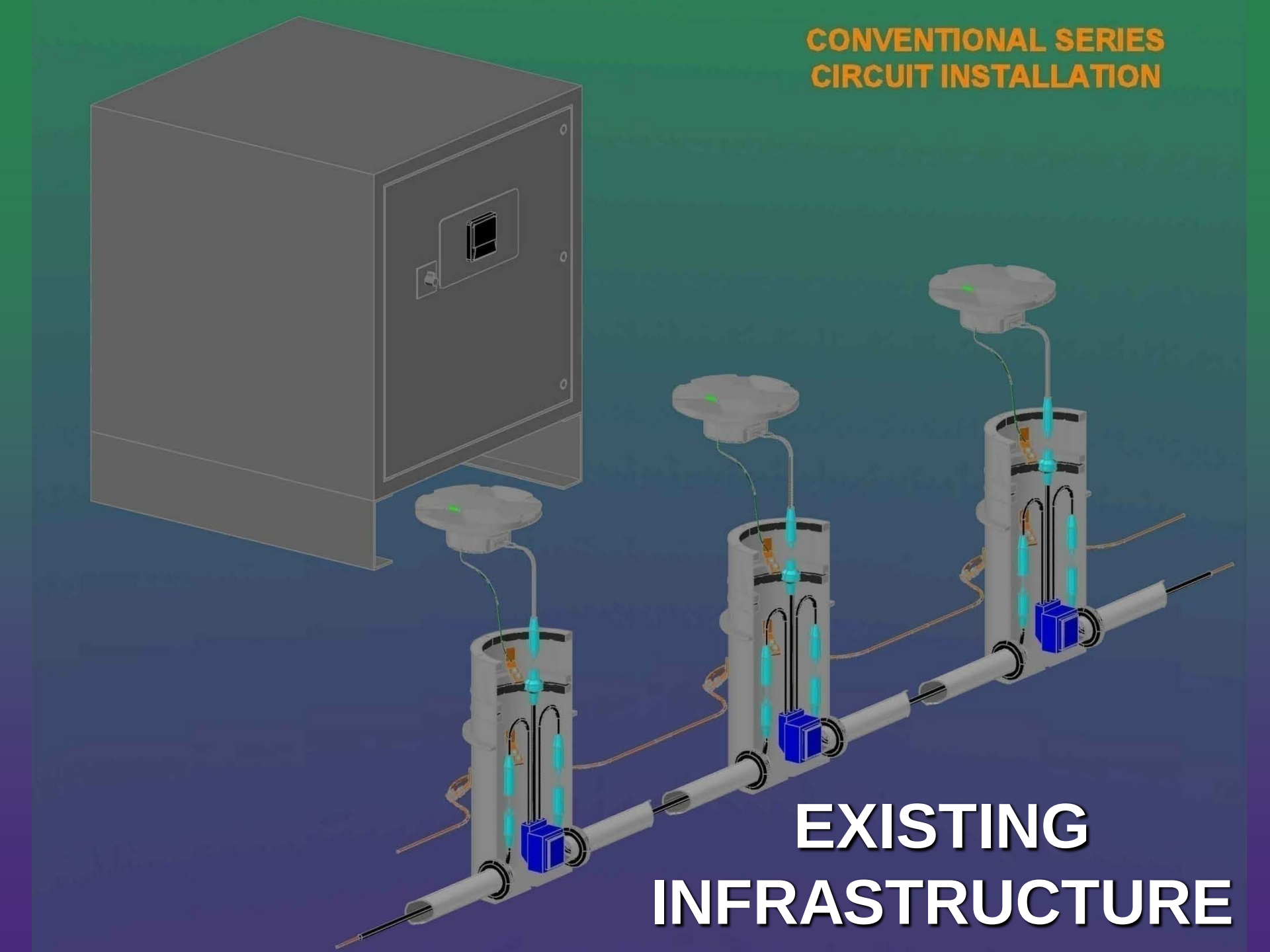


OIA DC CIRCUIT INSTALLATION TIME LINE

DATE	TIME	ACTION
PRIOR TO AUGUST 17		INSTALL POWER SUPPLY IN 18L VAULT AND PROVED INPUT POWER (240VAC) .
AUGUST 17 AND 18	2300-0500 HOURS	REMOVE EXISTING LED FIXTURES AND TRANSFORMERS, INSTALL NEW DC LED FIXTURES, REPAIR/REPLACE L-823 KITS AND BOLTS AS NEEDED, REPLACE 1 FIELD LIGHTNING ARRESTOR.
AUGUST 19	2300-0500 HOURS	COMPLETE NEW DC LED FIXTURE INSTALLATION, MAKE UP FIELD CONNECTIONS TO POWER SUPPLY AND TEST OPERATION.
AUGUST 20 THROUGH 22	2300-0500 HOURS	CONTINUE CIRCUIT BURN IN AND TESTING.
AUGUST 23	0800 HOURS	MOVE ALCS CONTROL AND MONITOR WIRING FROM EXISTING 6.6AMP CCR AND CONNECT TO NEW POWER SUPPLY AND BEGIN NORMAL OPERATION.

GOALS OF DC SYSTEM

- MAXIMIZE USE OF EXISTING ELECTRICAL INFRASTRUCTURE.
- MINIMUM SYSTEM COMPLEXITY.
- IMPROVED SAFETY.
- MAXIMUM ENERGY EFFICIENCY.
- SYSTEM RELIABILITY.

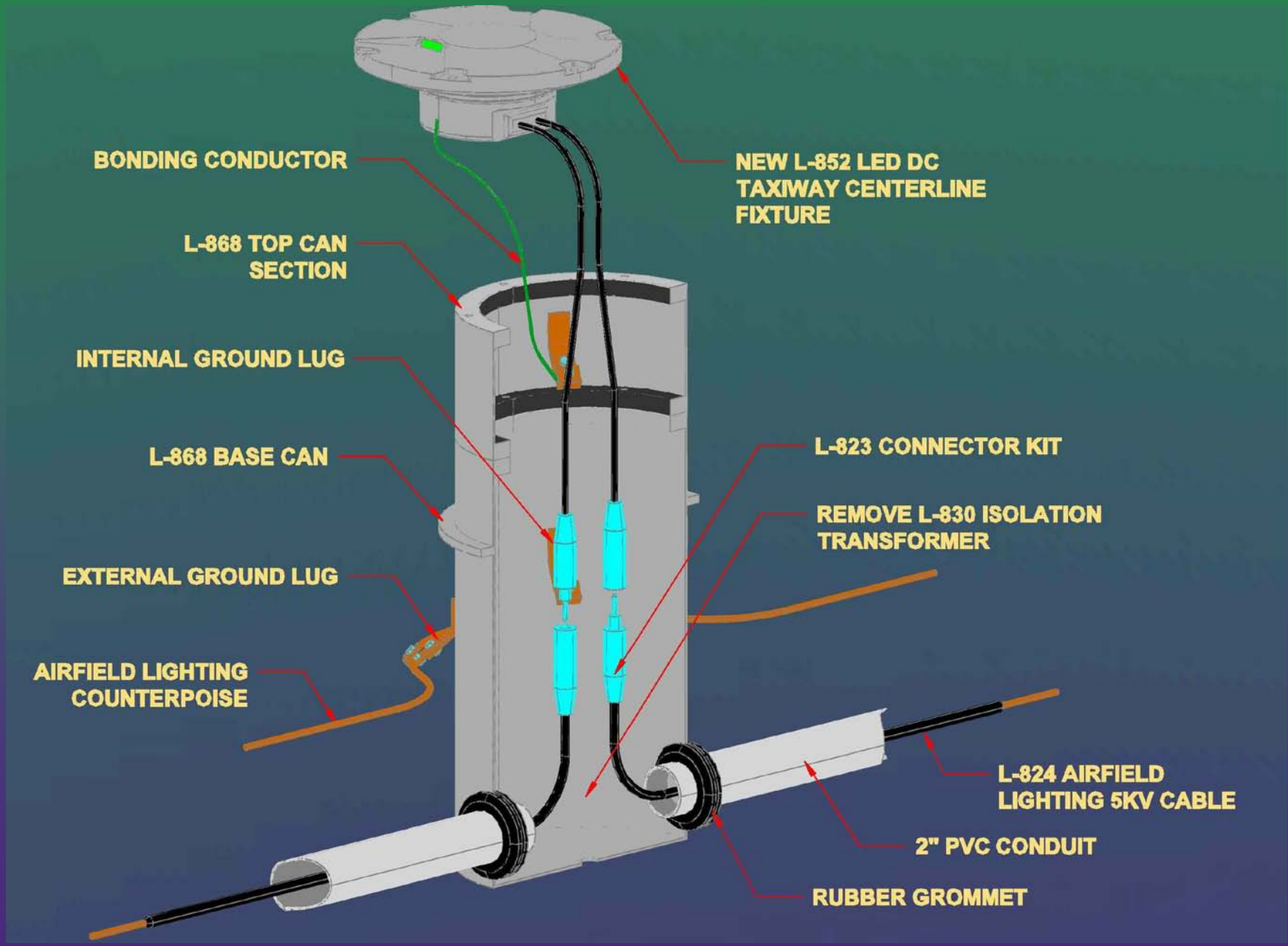

CONVENTIONAL SERIES
CIRCUIT INSTALLATION
EXISTING
INFRASTRUCTURE

EXISTING INFRASTRUCTURE

REUSE OF EXISTING COMPONENTS:

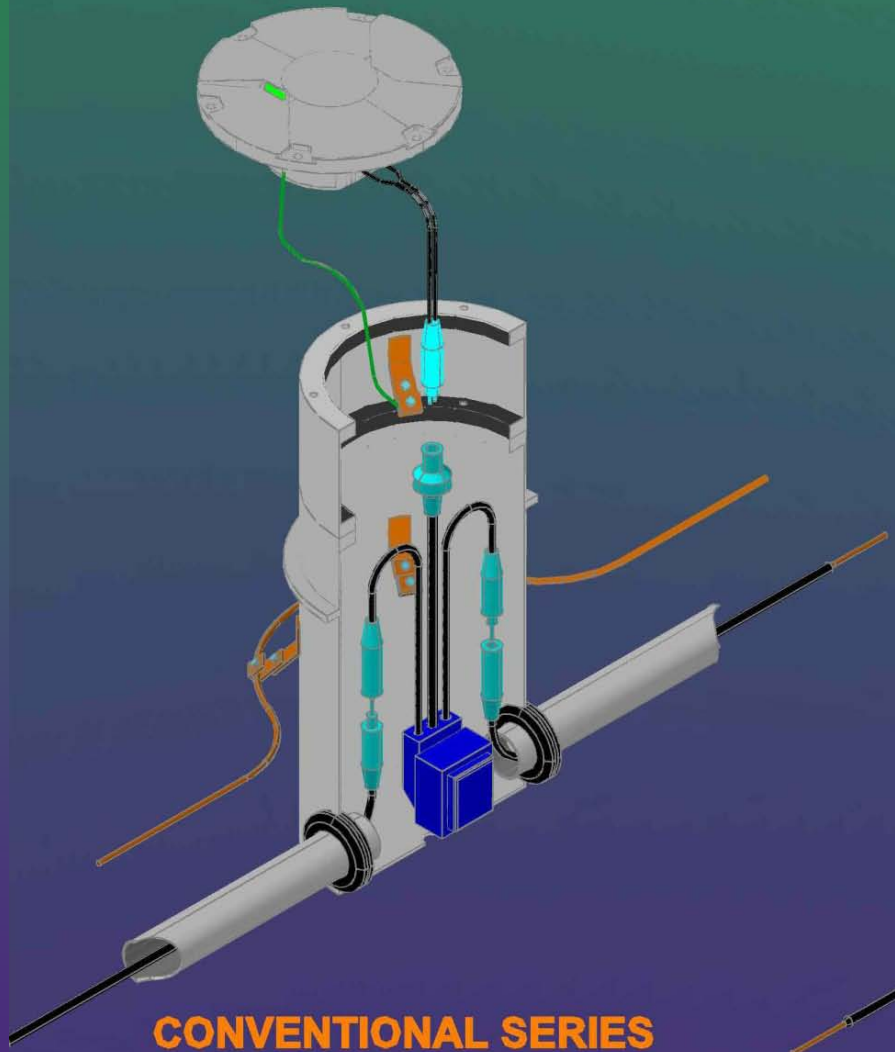
- DIRECT REPLACEMENT OF FIXTURES.
- REUSE BASE CAN AND CONDUIT SYSTEM.
- REUSE L-824 CABLE.
- REUSE L-823 CONNECTORS.

EXISTING INFRASTRUCTURE

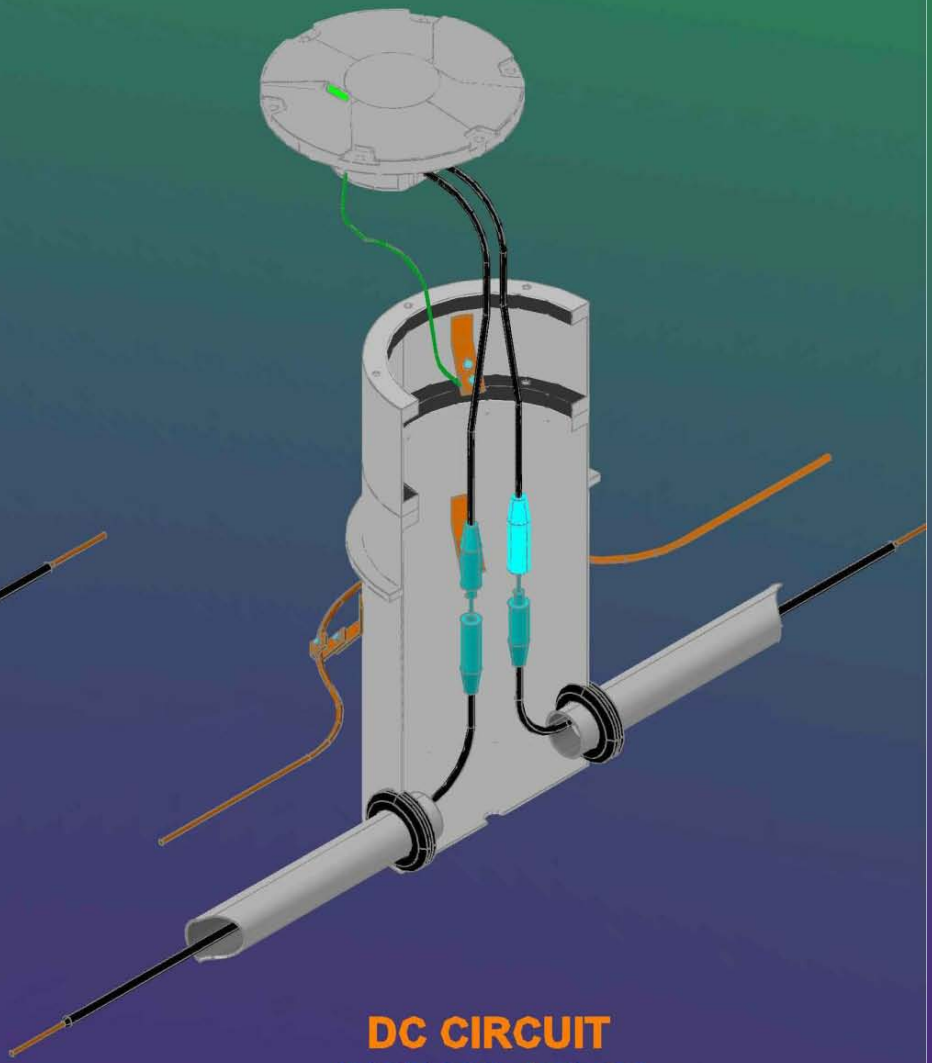


EXISTING INFRASTRUCTURE

SIDE BY SIDE COMPARISON

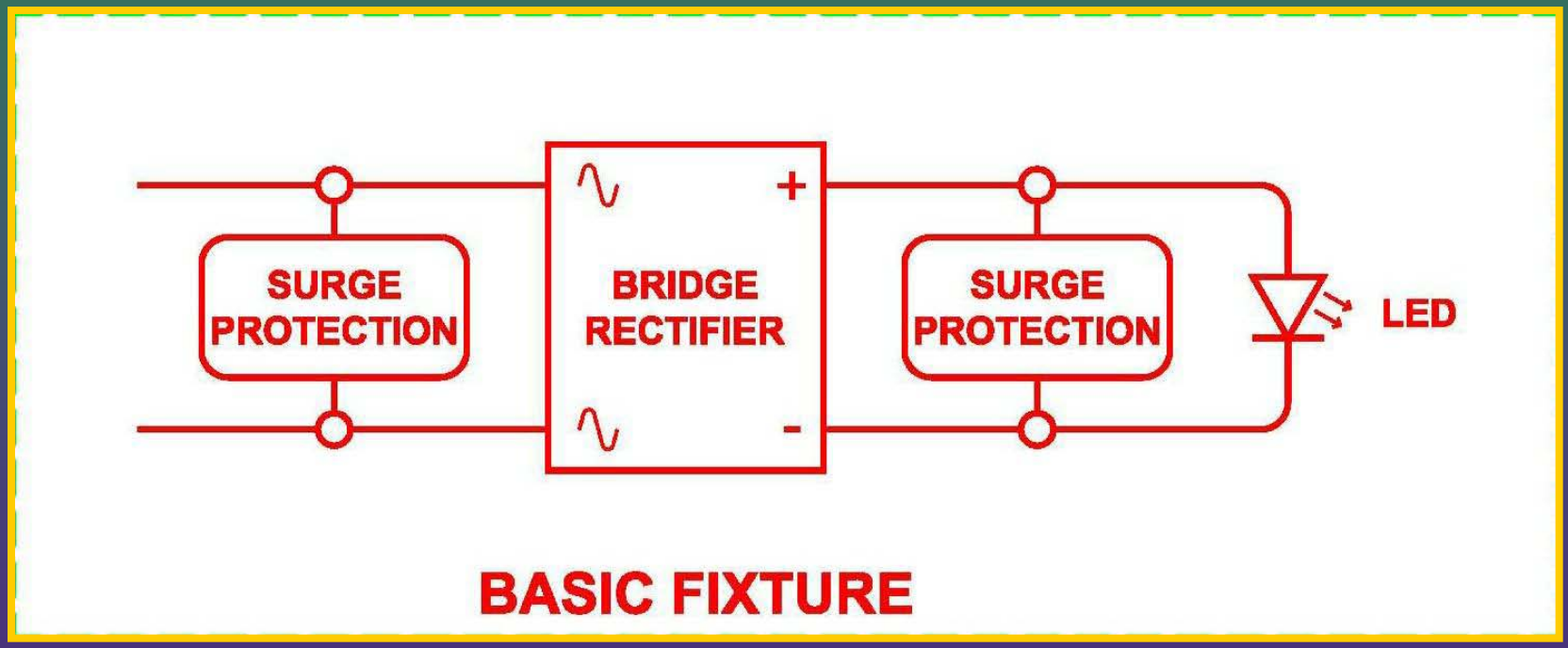


CONVENTIONAL SERIES CIRCUIT INSTALLATION



DC CIRCUIT INSTALLATION

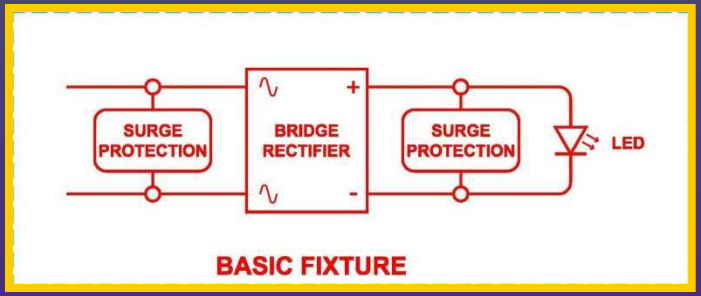
MINIMUM SYSTEM COMPLEXITY



MINIMUM SYSTEM COMPLEXITY

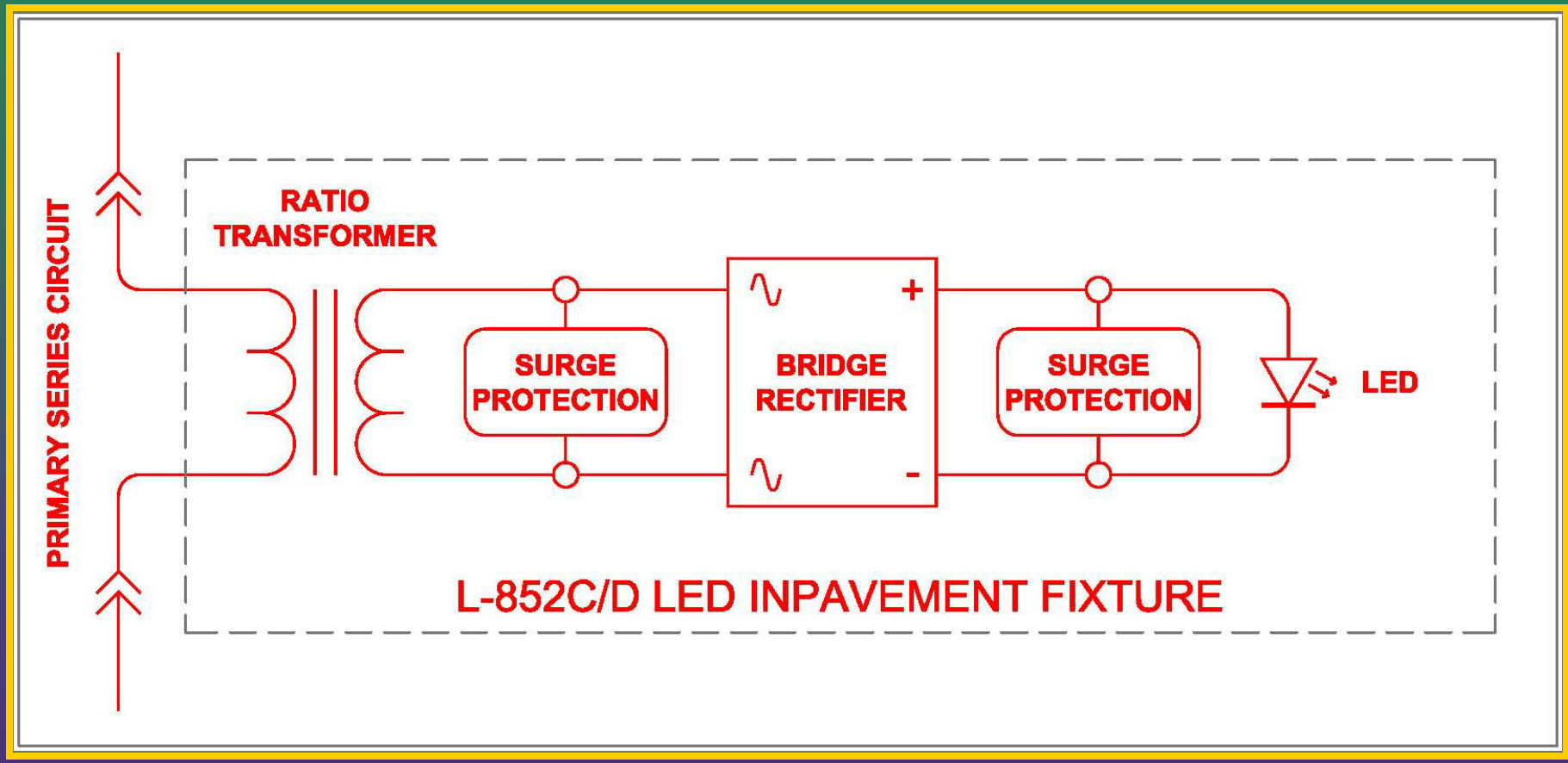
BRIDGE RECTIFIER;

- **POLARITY OF DC POWER SOURCE DOESN'T MATTER,**
- **ACCIDENTALLY SWITCHING THE POWER SOURCE LEADS HAS NO IMPACT.**



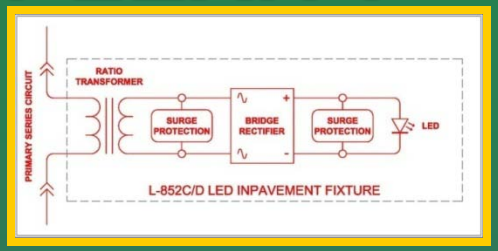
BASIC FIXTURE

MINIMUM SYSTEM COMPLEXITY



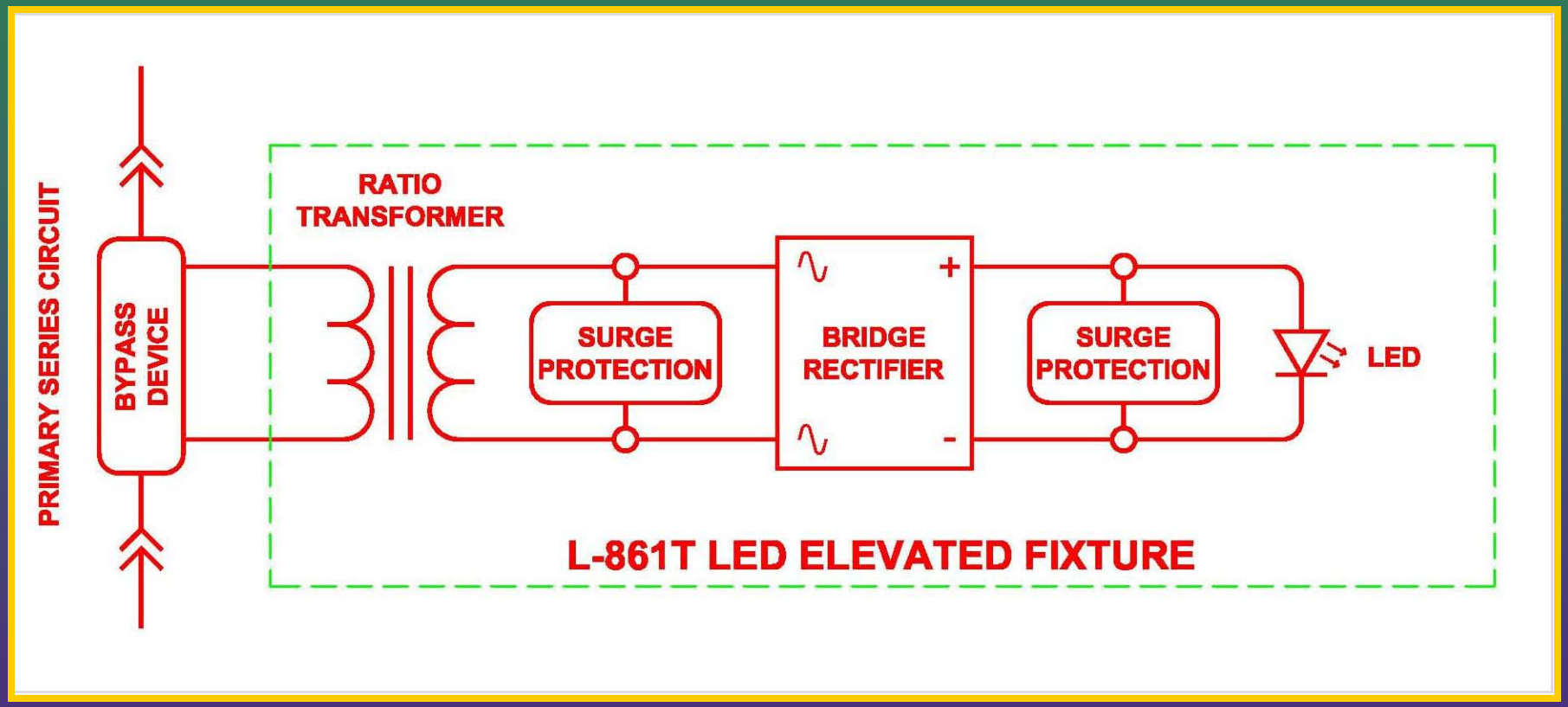
MINIMUM SYSTEM COMPLEXITY

RATIO TRANSFORMER;



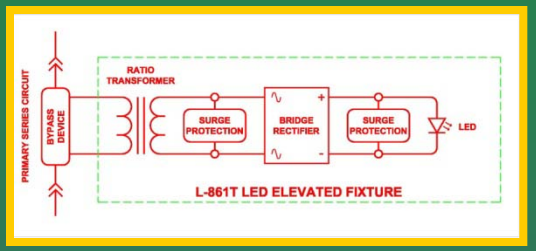
- **EACH LED TYPE REQUIRES A SPECIFIC CURRENT FOR PROPER OPERATION.**
- **THE RATIO TRANSFORMER CONVERTS THE POWER SUPPLY OUTPUT CURRENT TO THE CURRENT REQUIRED BY THE LED.**
- **ALLOWS FOR A SINGLE POWER SUPPLY OUTPUT CURRENT TO BE USED IN ANY AIRFIELD APPLICATION.**
- **PROVIDES ISOLATION FOR THE FIXTURE.**

MINIMUM SYSTEM COMPLEXITY



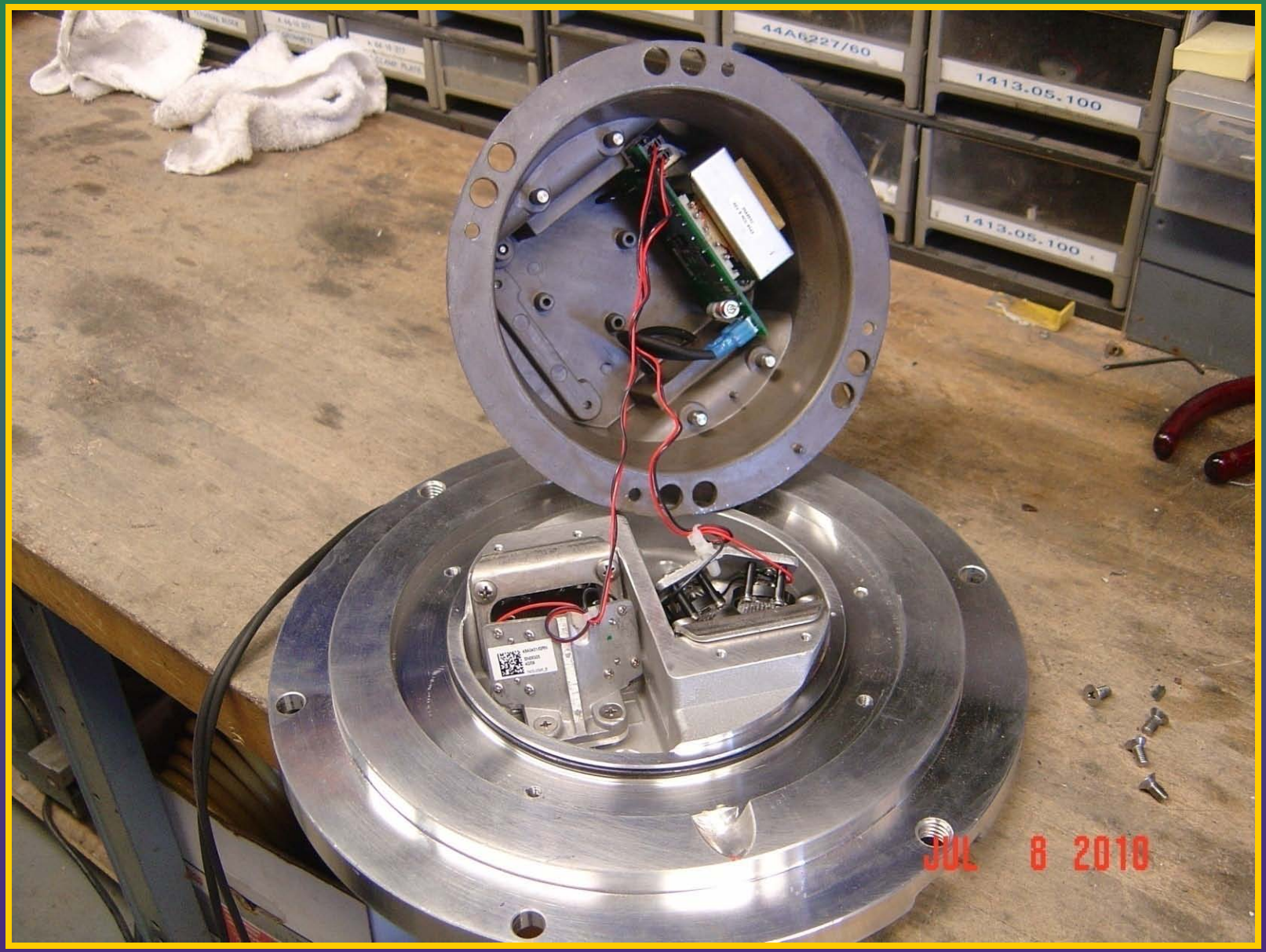
MINIMUM SYSTEM COMPLEXITY

BYPASS DEVICE;

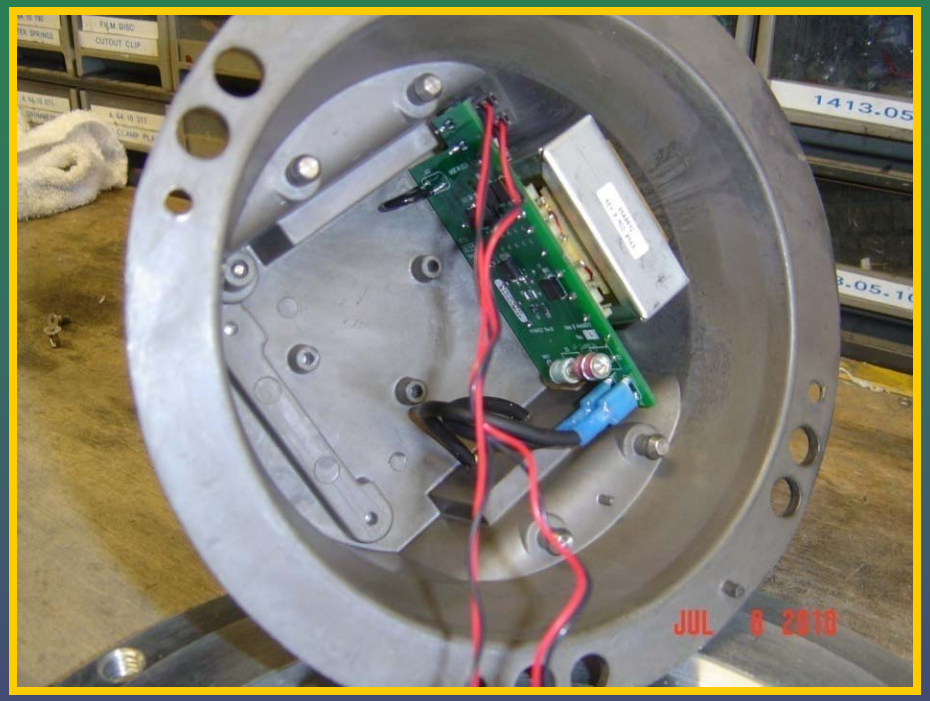


- COMPACT & WATERPROOF
- ISOLATES THE ELEVATED FIXTURE FROM THE SERIES CIRCUIT.
- ENSURES THERE IS A LOW VOLTAGE ON THE FIXTURE INPUT TERMINALS.
- BYPASSES THE FIXTURE IN CASE AN ELEVATED FIXTURE IS KNOCKED OVER AND OPENS THE CIRCUIT AT THE FIXTURE'S FRANGIBLE COUPLING.

MINIMUM SYSTEM COMPLEXITY

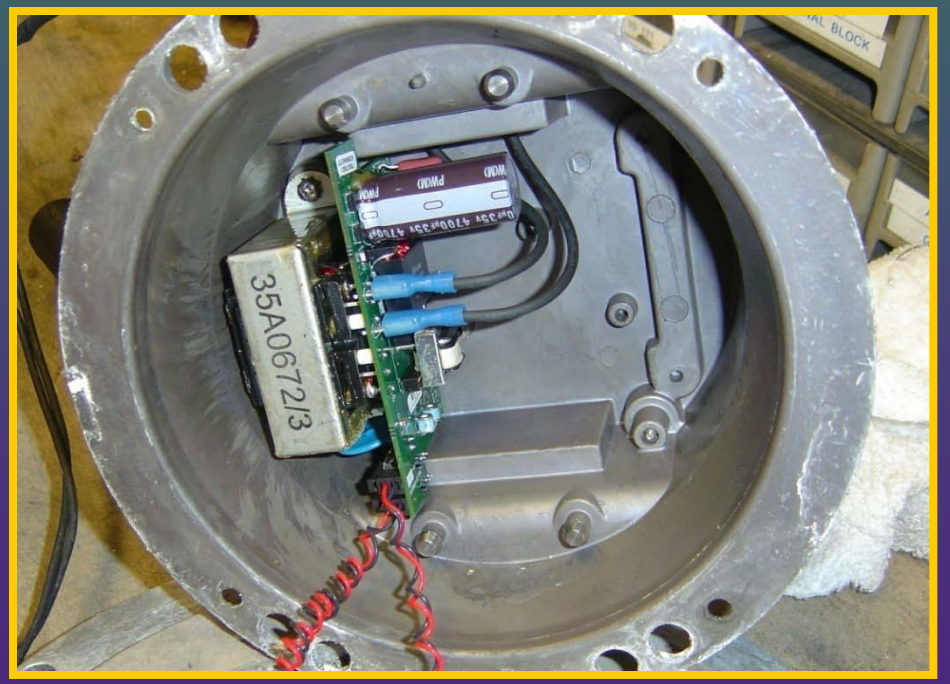


MINIMUM SYSTEM COMPLEXITY



DC LED FIXTURE

STANDARD
LED FIXTURE



MINIMUM SYSTEM COMPLEXITY

POWER SUPPLY:

- **MUST BE ABLE TO ADJUST LIGHTING INTENSITY,**
- **LEDS NEED FULL NOMINAL CURRENT TO PROVIDE PROPER ILLUMINATION, LEDS MAY ILLUMINATE UNEVENLY AT LOWER THAN NOMINAL CURRENT LEVELS.**
- **PULSE WIDTH MODULATION IS THE LOGICAL CHOICE. PWM TURNS LED FULLY ON FOR A SPECIFIC TIME PERIOD.**

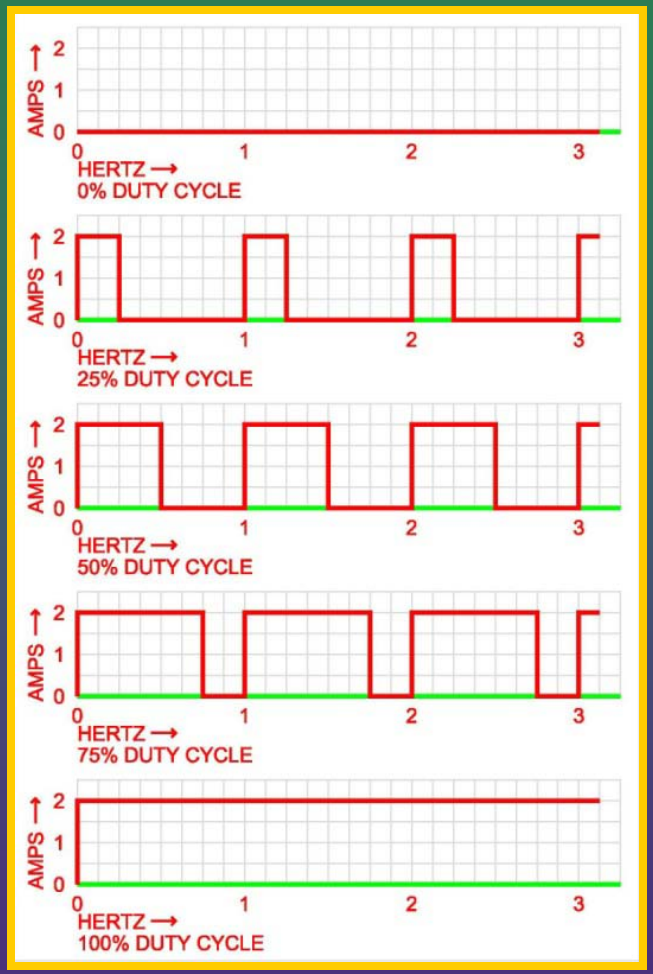
MINIMUM SYSTEM COMPLEXITY

PULSE WIDTH MODULATION (PWM):

- **WIDELY USED RELIABLE MEANS OF CONTROLLING POWER TO A LOAD,**
- **RELIABLE, FIRST USED IN THE 1960’S,**
- **VERY EFFICIENT,**
- **USED IN COMPUTER POWER SUPPLIES,**
- **MOTOR SPEED CONTROLLERS,**
- **ELECTRIC STOVES, LAMP DIMMERS, ETC.**

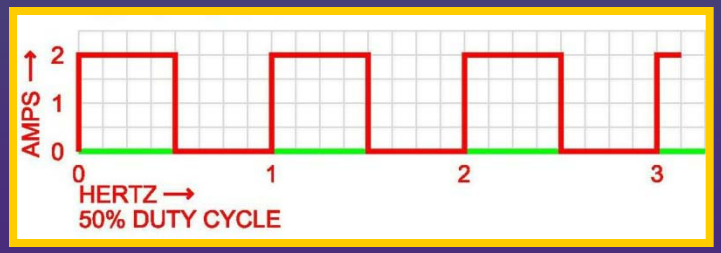
WHAT IS PWM?

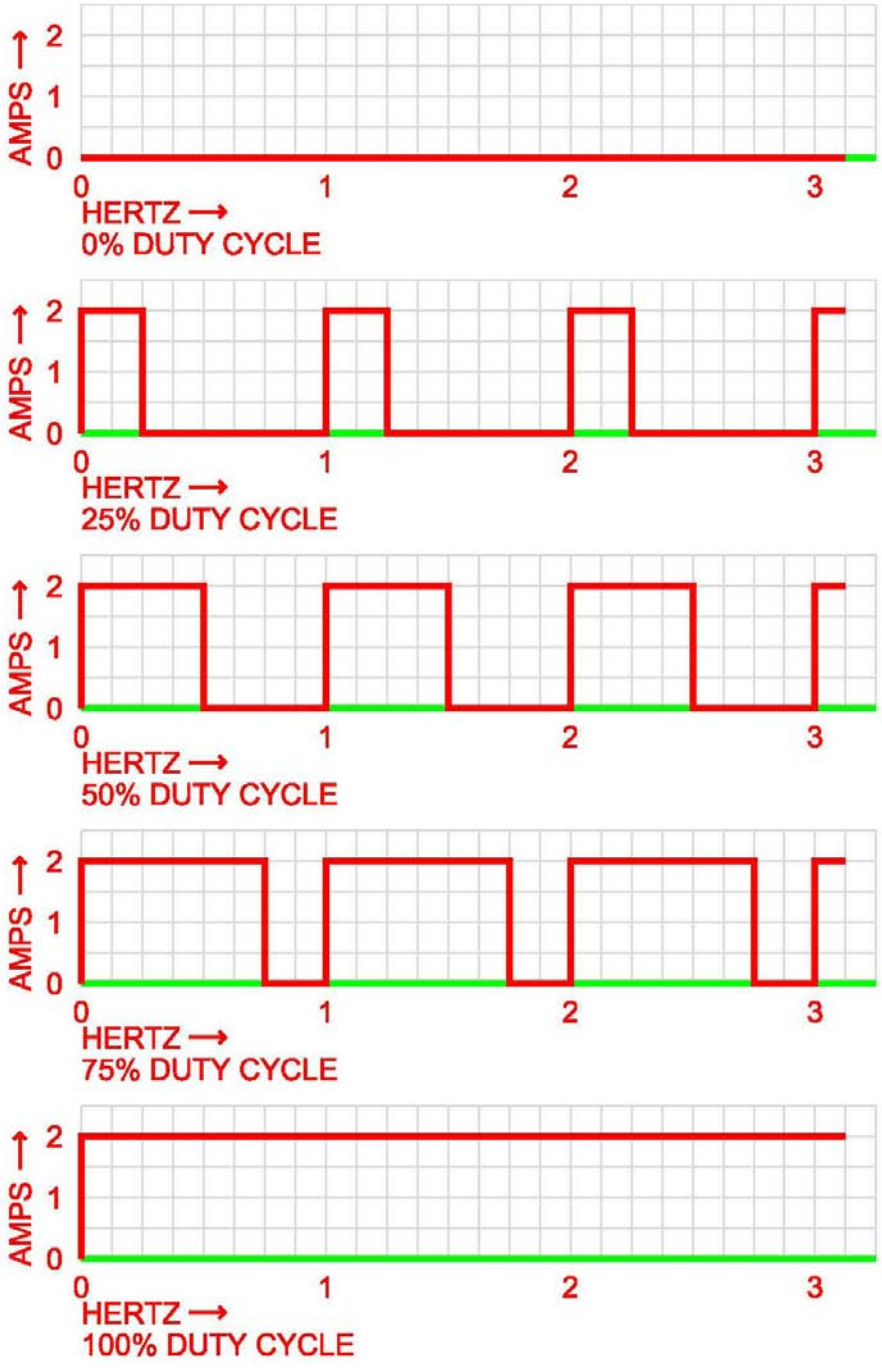
- PROVIDES INTERMEDIATE AMOUNTS OF ELECTRICAL POWER BETWEEN FULLY ON AND FULLY OFF,
- PWM PROVIDES FULL CURRENT TO THE DEVICE FOR A VARYING AMOUNT OF TIME,
- VARYING DUTY CYCLE,



WHAT IS PWM?

- THE TERM DUTY CYCLE DESCRIBES THE PROPORTION OF ON TIME TO THE REGULAR INTERVAL OR PERIOD OF TIME,
- A LOW DUTY CYCLE CORRESPONDS TO LOW POWER, BECAUSE THE POWER IS OFF FOR MOST OF THE TIME,
- DUTY CYCLE IS EXPRESSED IN PERCENT, 100% BEING FULLY ON.





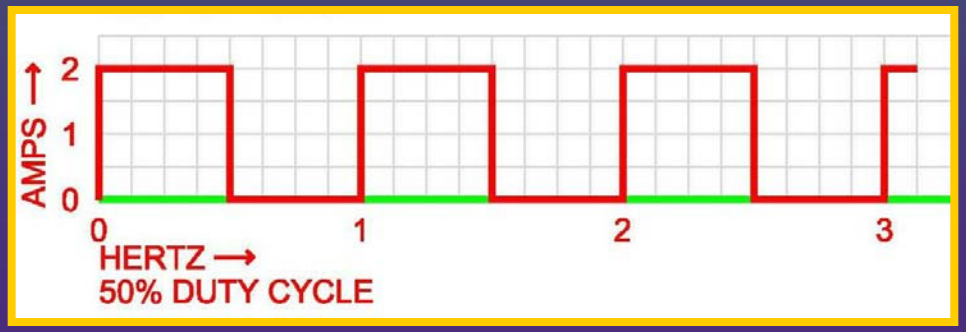
PWM DUTY CYCLE

HIGHER % OF DUTY CYCLE PROVIDES MORE POWER TO THE LED AT FULL CURRENT.

OPERATES AT A HIGH ENOUGH FREQUENCY TO APPEAR TO BE CONTINUOUSLY ON.

MINIMUM SYSTEM COMPLEXITY

- THE PRIMARY SERIES CIRCUIT OPERATES AT 2 AMPS,
- THE POWER SUPPLY OUTPUT VOLTAGE IS 1,000 VOLTS MAXIMUM,
- DUTY CYCLE IS ADJUSTED TO REPRESENT THE EB-67B INTENSITY RATIOS.



MINIMUM SYSTEM COMPLEXITY

3-STEP

- B10 15%
- B30 40%
- B100 100%

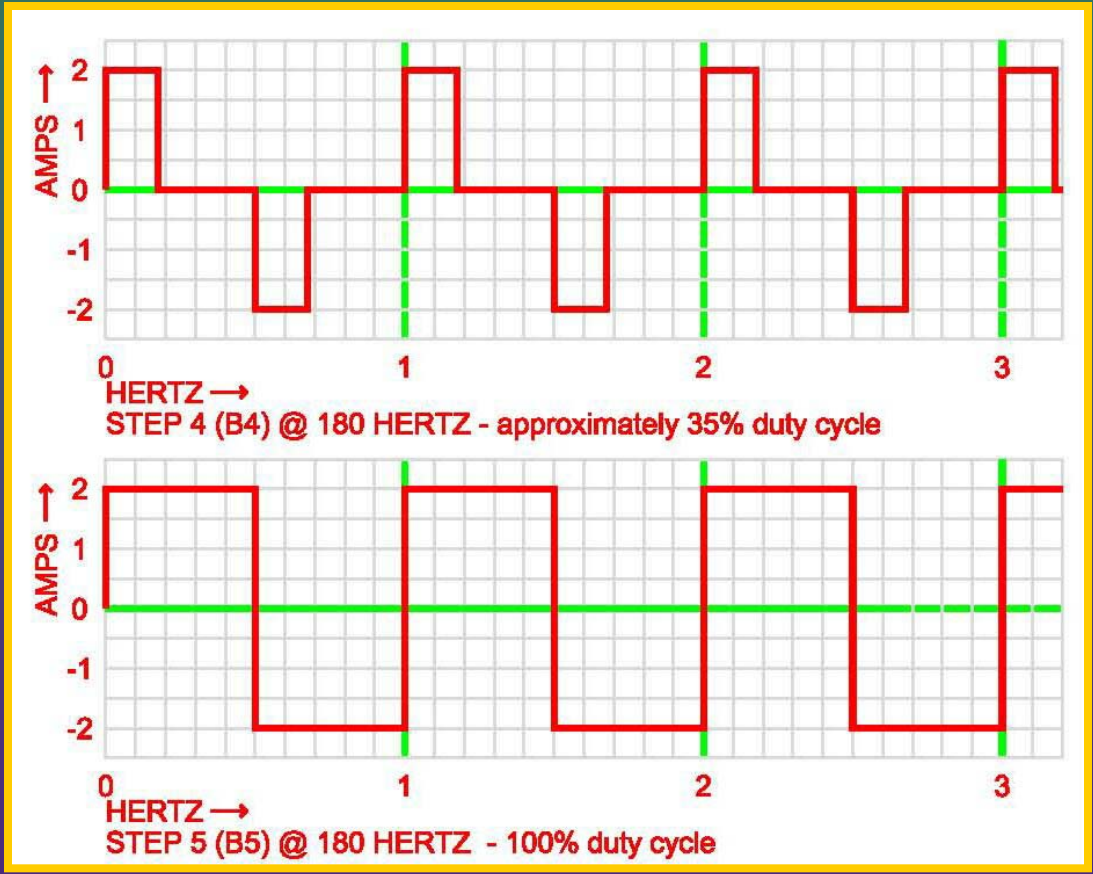
5-STEP

- B1 1.0%
- B2 2.0%
- B3 7.5%
- B4 35%
- B5 100%

PWM DUTY CYCLES

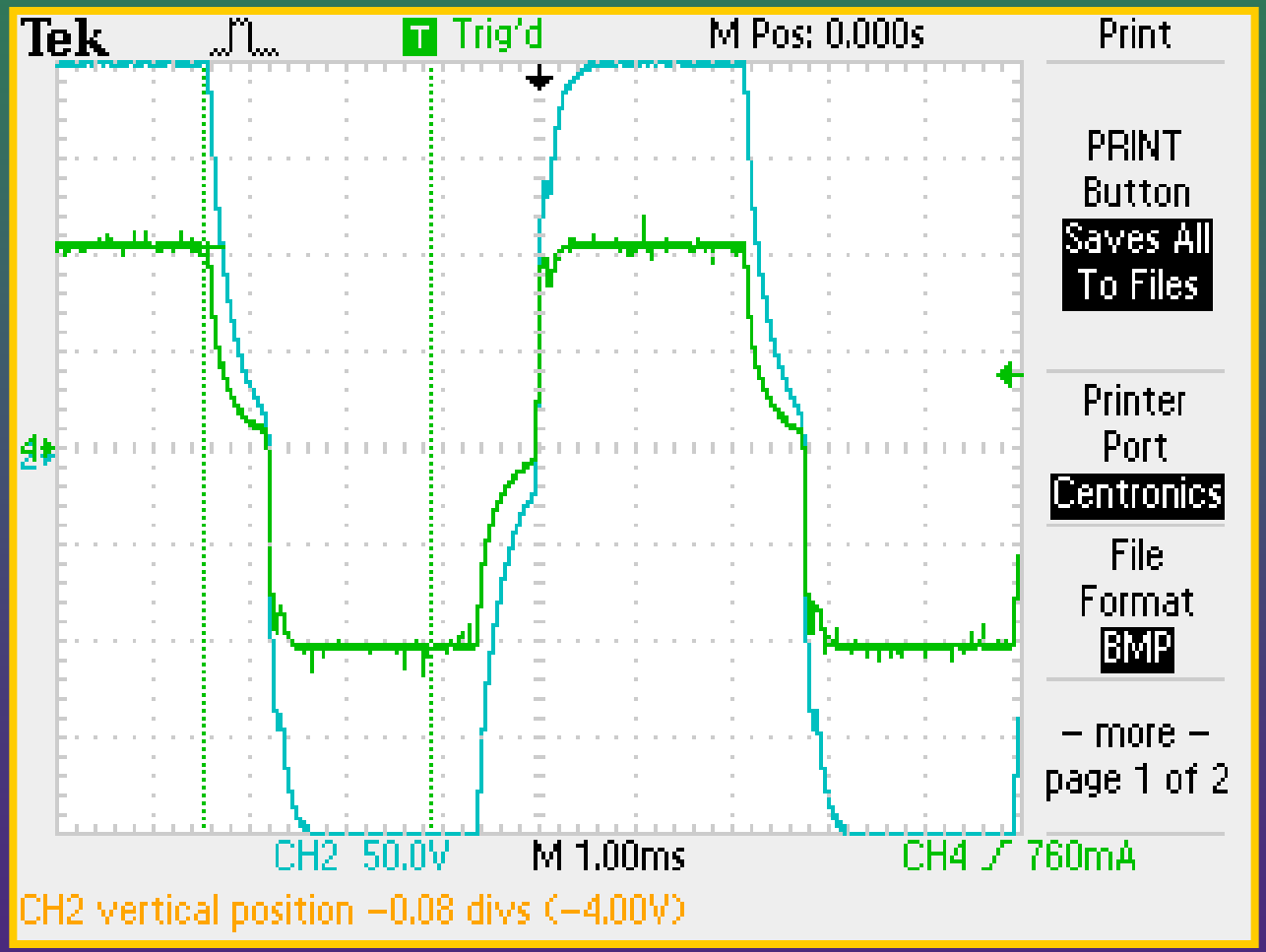
MINIMUM SYSTEM COMPLEXITY

- POWER SUPPLY USES PWM.
- POWER SUPPLY OUTPUT ALTERNATES AT 180 HZ.



MINIMUM SYSTEM COMPLEXITY

POWER SUPPLY OUTPUT ALTERNATES AT 180 HZ.



MINIMUM SYSTEM COMPLEXITY

ALTERNATING PWM OFFERS THE FOLLOWING ADVANTAGES:

- **ELIMINATES THE POSSIBILITY OF WHAT IS CALLED THE "*ARC WELDER EFFECT*". IF IT WERE A PURE DC OUTPUT, AN ARC WOULD BURN CONTINUOUSLY AND INSULATION WOULD FAIL SOONER.**
- **ALTERNATING THE OUTPUT QUENCHES THE ARC AT EACH ZERO CROSSING, HELPING TO PREVENT INSULATION FAILURE.**

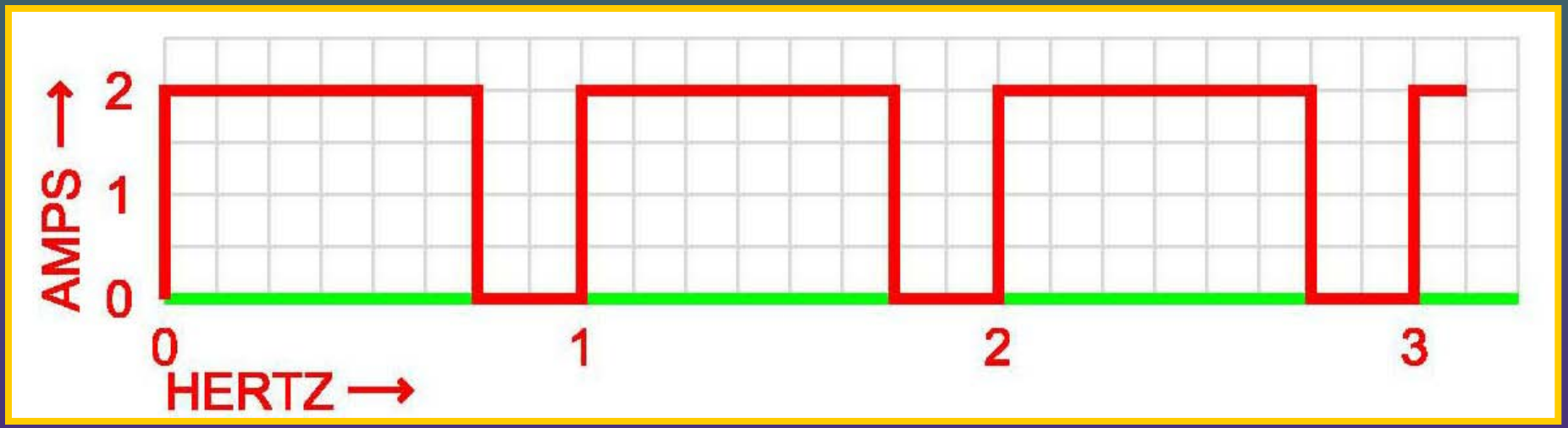
MINIMUM SYSTEM COMPLEXITY

ALTERNATING PWM OFFERS THE FOLLOWING ADVANTAGES:

- **ALTERNATING THE PWM OUTPUT ALSO ELIMINATES ANY POSSIBLE CONCERN THAT A PURE DC OUTPUT WOULD RESULT IN INCREASED GALVANIC CORROSION OF AIRFIELD COMPONENTS.**
- **ALLOWS CURRENT TO PASS THROUGH THE RATIO TRANSFORMER AND BYPASS DEVICE.**

MINIMUM SYSTEM COMPLEXITY

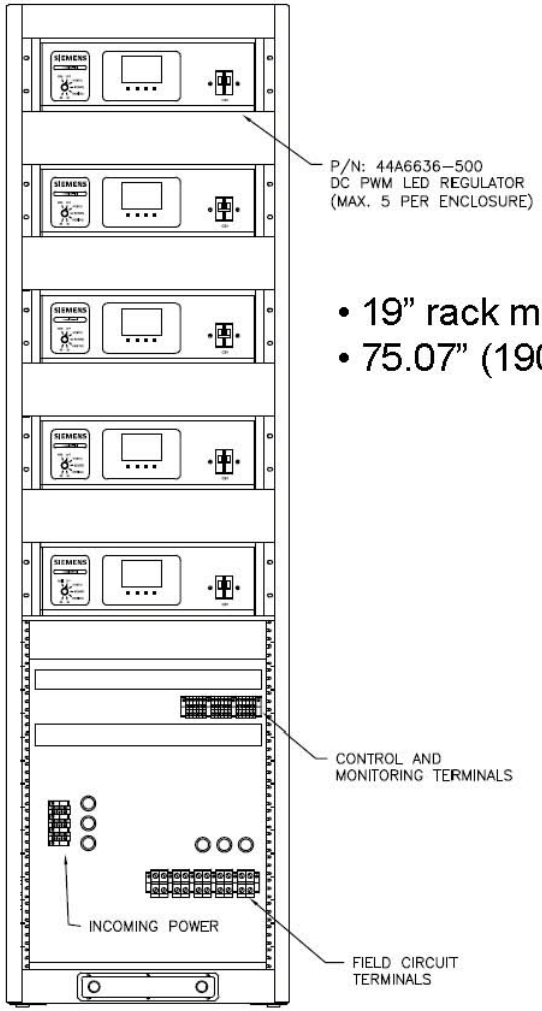
AFTER PASSING THROUGH THE RATIO TRANSFORMER AND BRIDGE RECTIFIER THE PWM CURRENT TO THE LED IS CONVERTED TO ALL POSITIVE CYCLES AT 360 HERTZ.



MINIMUM SYSTEM COMPLEXITY

- THE POWER SUPPLY IS SMALL, 19” RACK MOUNT.
- MULTIPLE POWER SUPPLIES CAN BE INSTALLED IN THE SAME VOLUME AS A CONVENTIONAL CCR.
- 3-STEP OR 5-STEP.

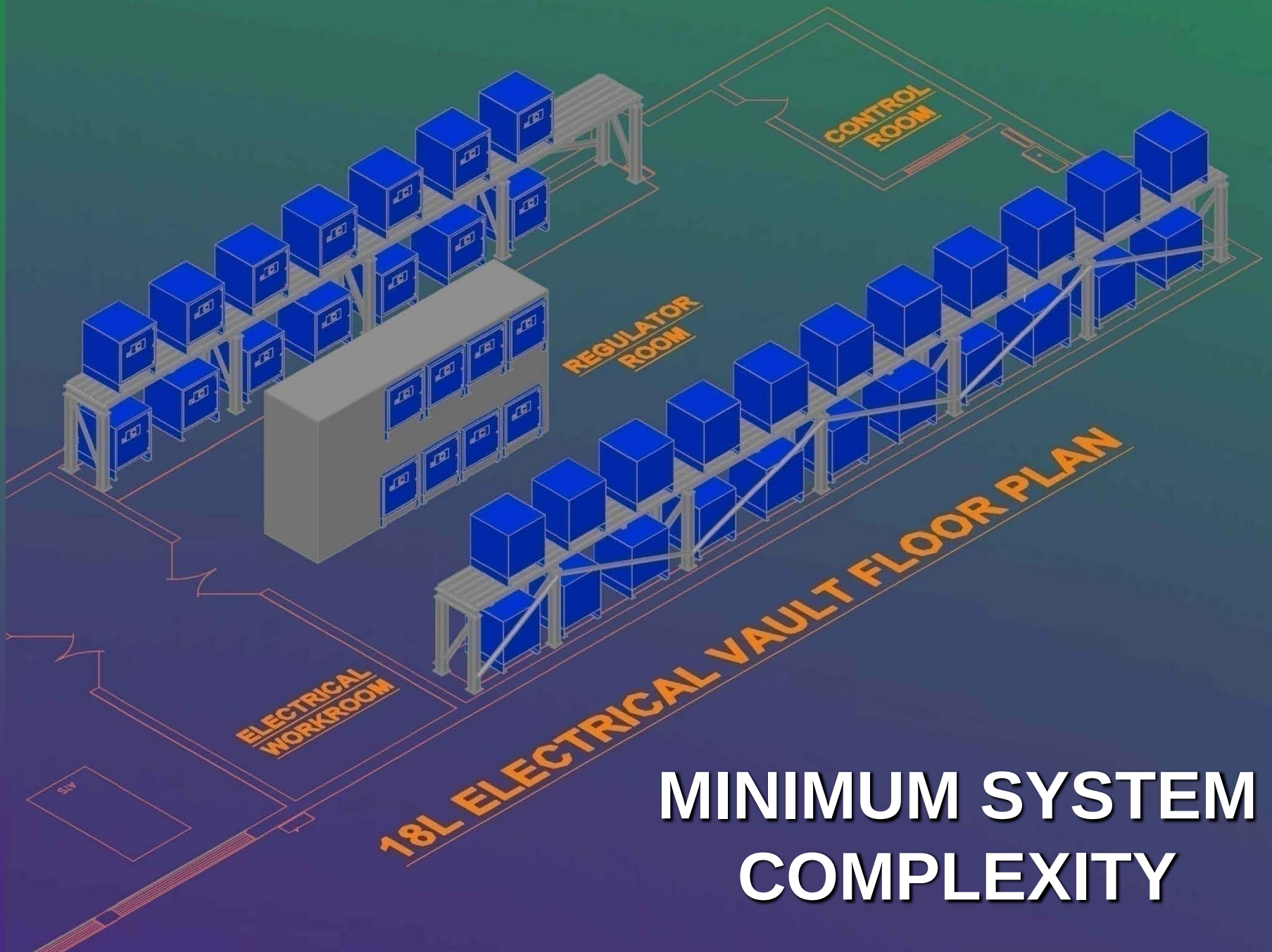
MINIMUM SYSTEM COMPLEXITY



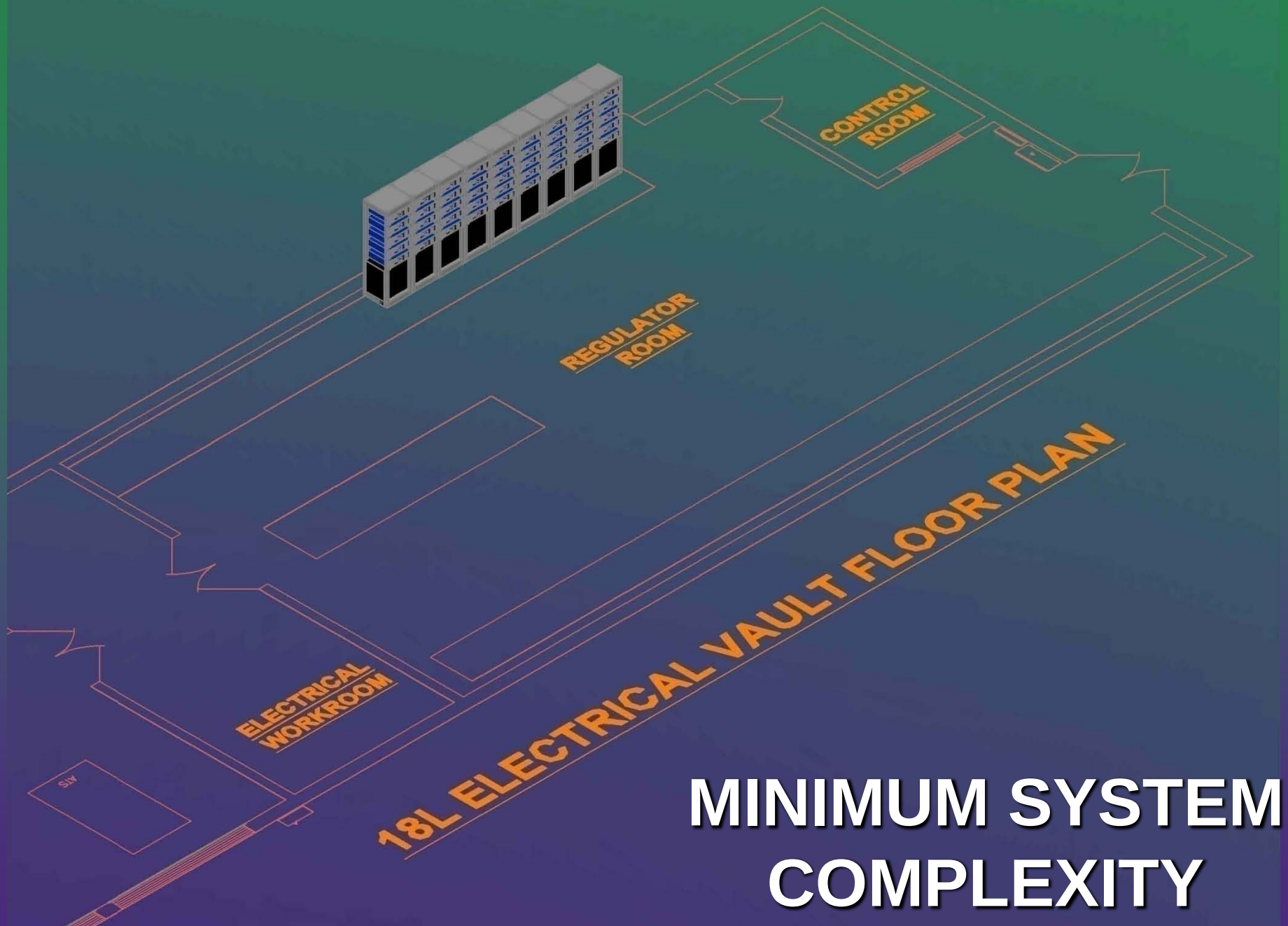
Example APS Installation

- 19” rack mount enclosure for five power supplies
- 75.07” (190.7 cm) High x 21.3” (54.1 cm) Deep

MINIMUM SYSTEM COMPLEXITY



MINIMUM SYSTEM COMPLEXITY



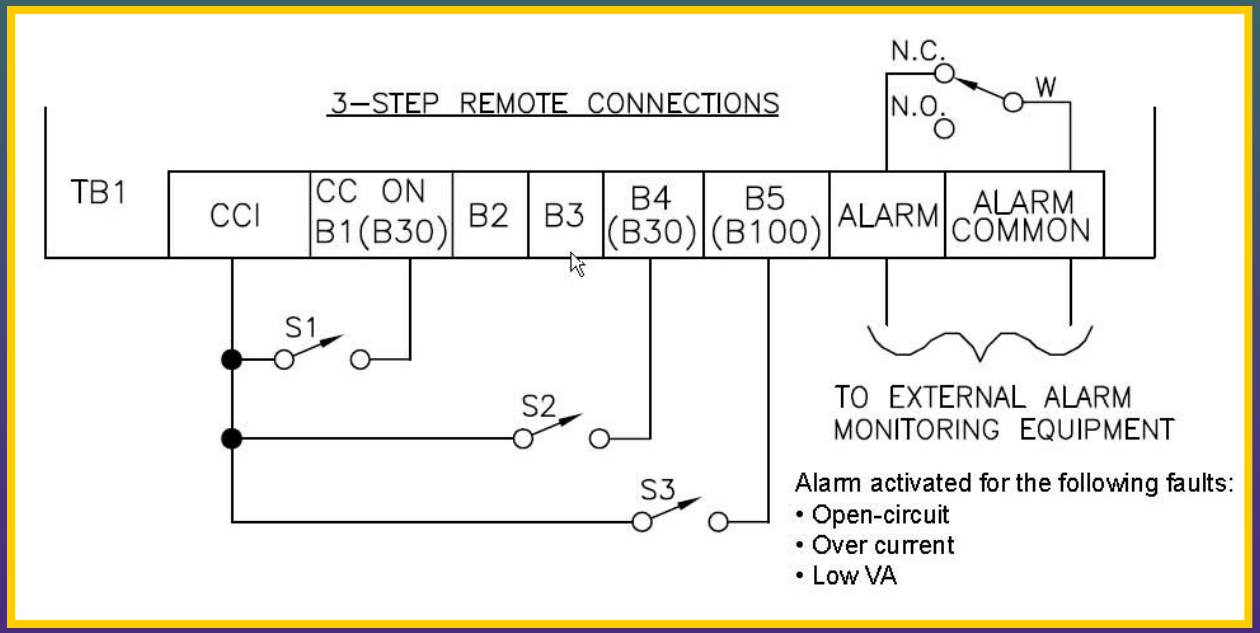
MINIMUM SYSTEM COMPLEXITY

MINIMUM SYSTEM COMPLEXITY

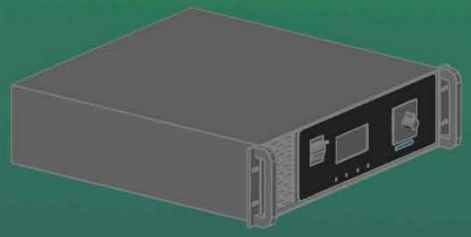
- MONITORS LOW VA, OPEN CIRCUIT AND OVER CURRENT.
- LCD DISPLAY ON FRONT PANEL. THE LCD PROVIDES STATUS INFORMATION, REMOTE/LOCAL STATUS, STEP SETTING AND ACTUAL OUTPUT VOLTAGE.

MINIMUM SYSTEM COMPLEXITY

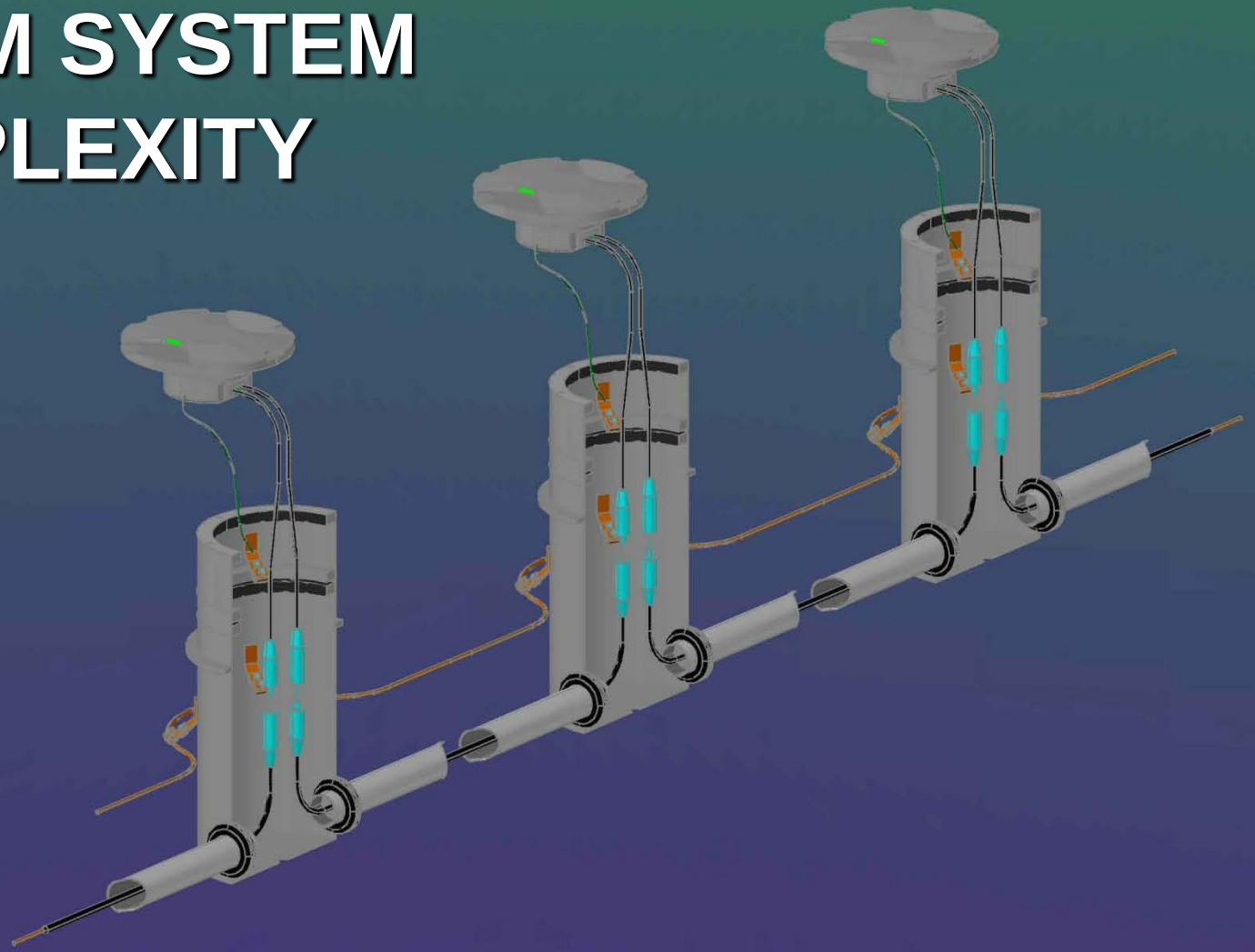
- REMOTE CONTROL WIRING SAME AS A CONVENTIONAL CCR.
- 2 AMP POWER SUPPLY USED WITH ALL FIXTURES.



DC SERIES
CIRCUIT INSTALLATION

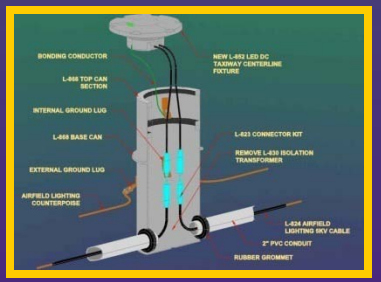


MINIMUM SYSTEM COMPLEXITY



IMPROVED SAFETY

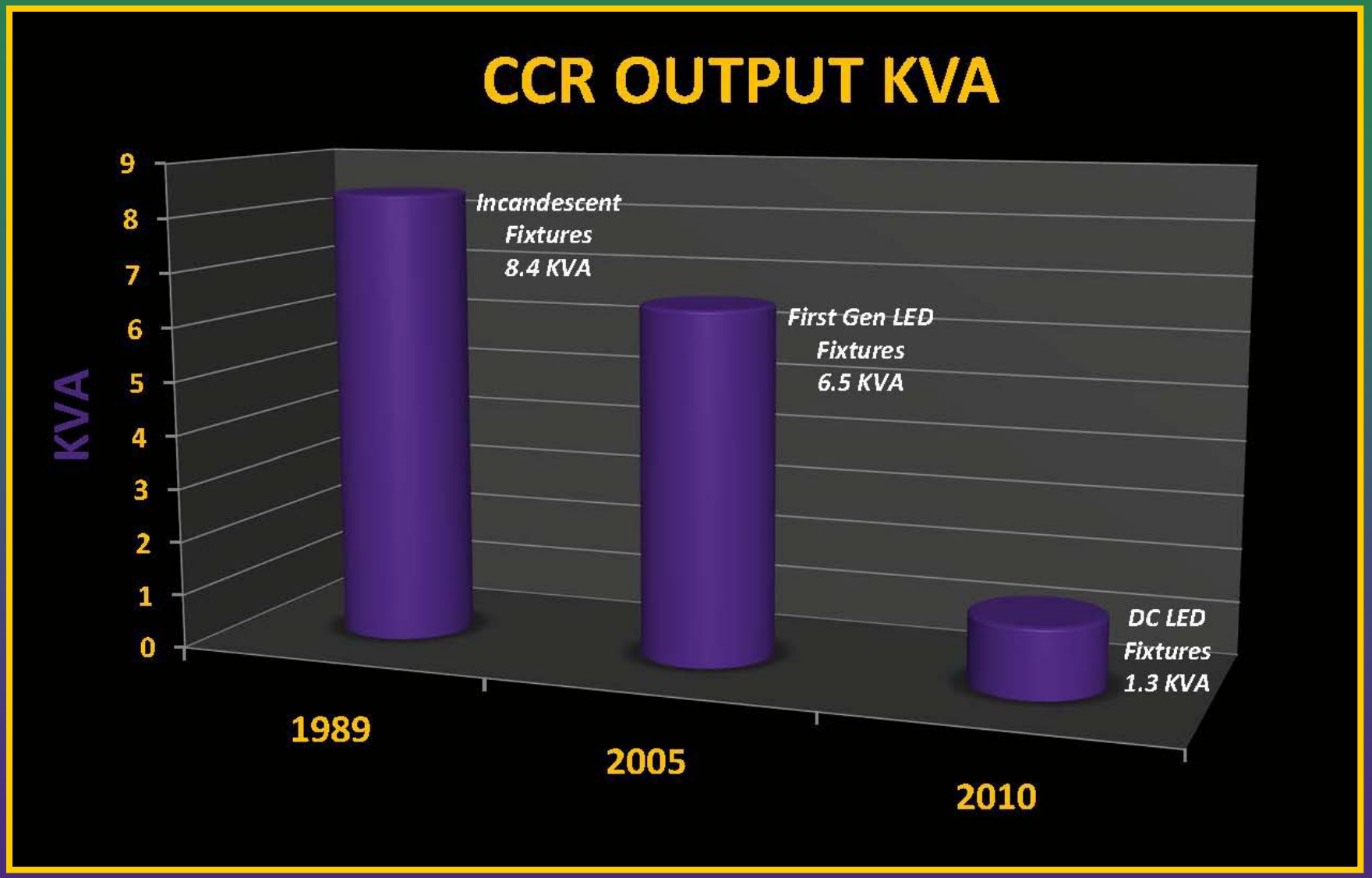
- THE MAXIMUM OUTPUT VOLTAGE FOR A 1 KW POWER SUPPLY IS 500 VOLTS.
- THE MAXIMUM OUTPUT VOLTAGE FOR A 2 KW POWER SUPPLY IS 1,000 VOLTS.
- NEW DC SYSTEM IS SIMILAR TO EXISTING SERIES CIRCUIT. TROUBLESHOOTING METHODS ARE SIMILAR. AIRFIELD ELECTRICIANS ARE FAMILIAR WITH SERIES CIRCUIT OPERATION.



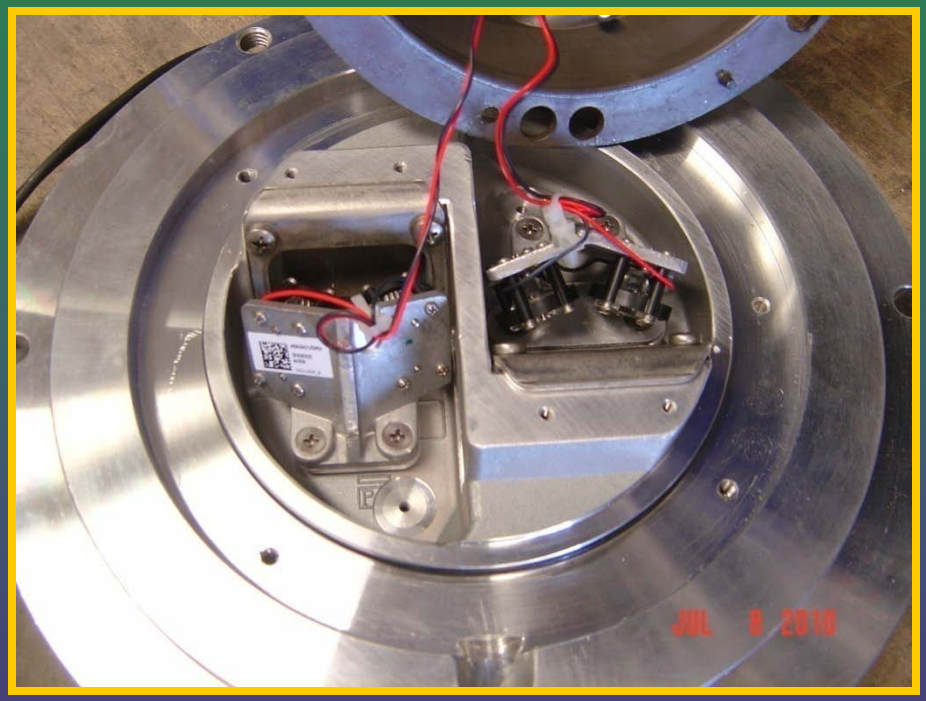
IMPROVED SAFETY

GOAA NOTED DEMONSTRATION AREA BY SIGNAGE .

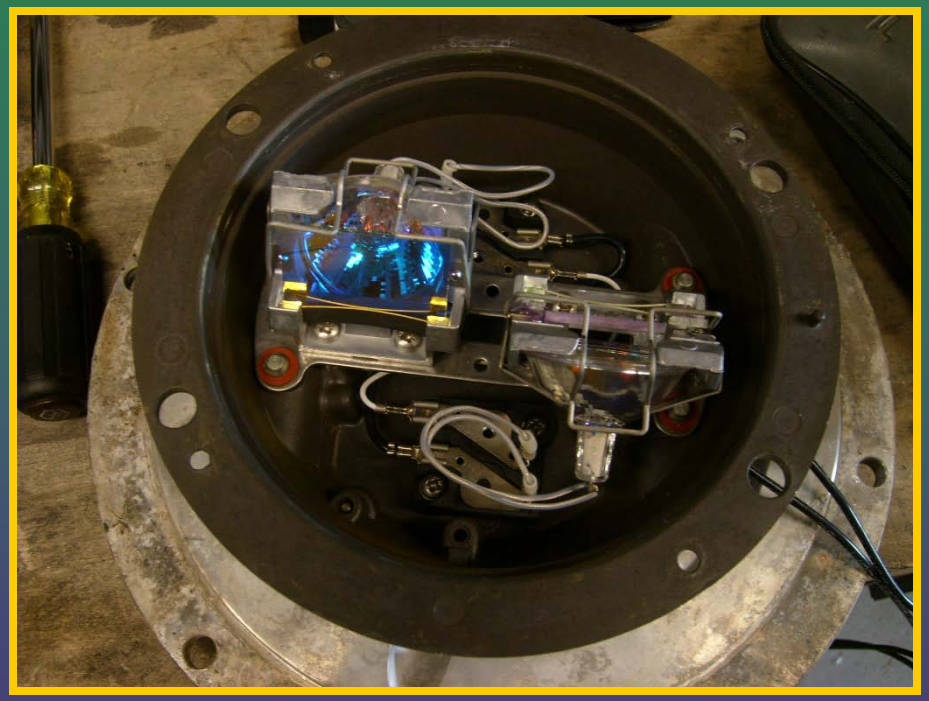
MAXIMUM ENERGY EFFICIENCY



MAXIMUM ENERGY EFFICIENCY

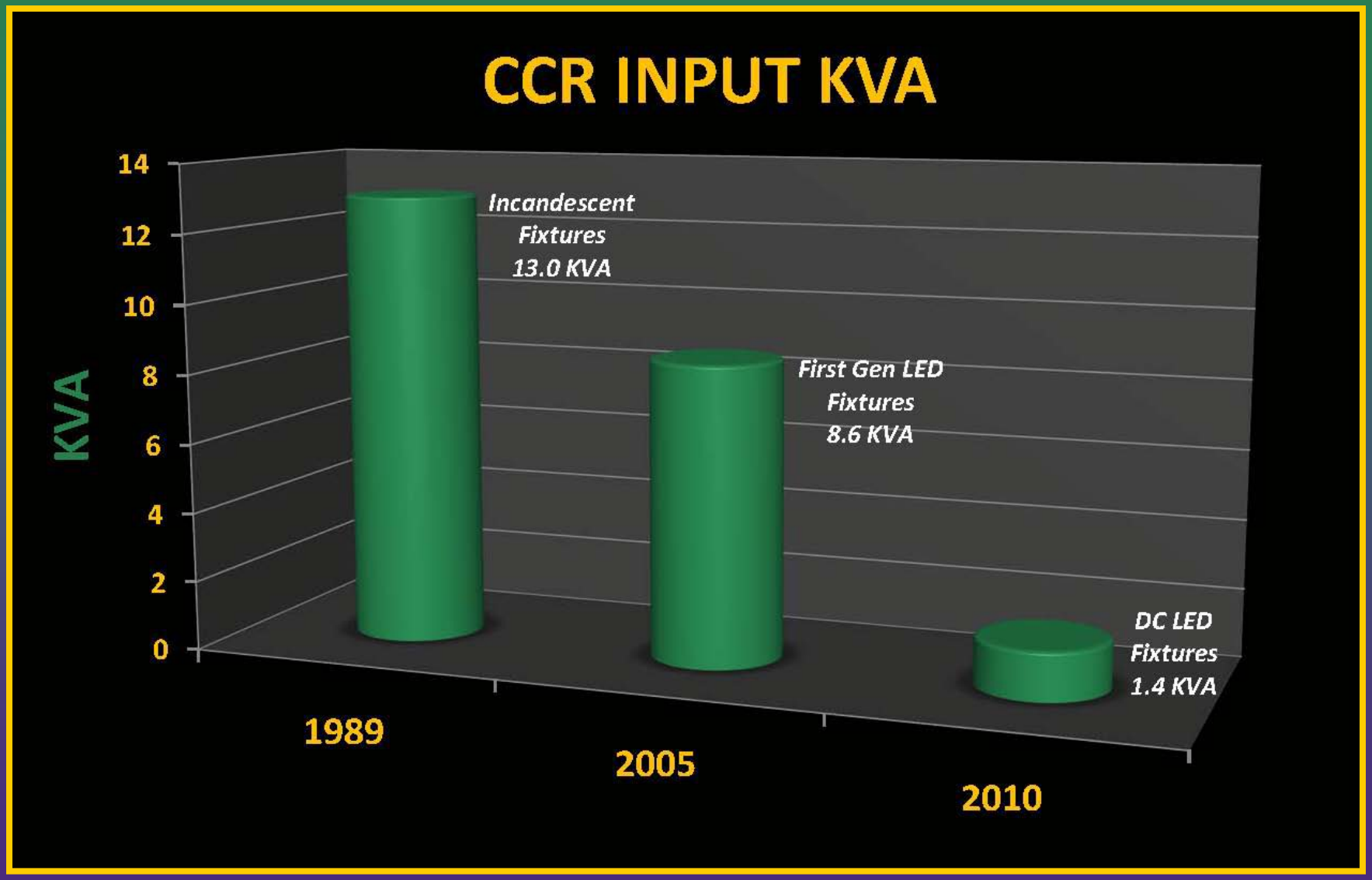


DC LED L-852D
10.2 WATTS



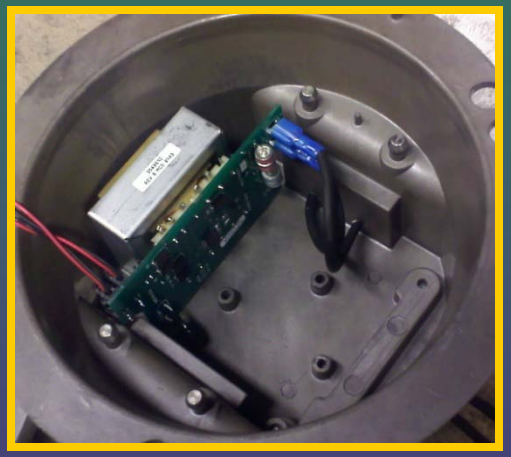
INCANDESCENT L-852D
60 WATTS

MAXIMUM ENERGY EFFICIENCY



SYSTEM RELIABILITY

- SYSTEM HAS MINIMAL COMPLEXITY RESULTING IN GREATER RELIABILITY.
- FEWER COMPONENTS TO FAIL THAN CONVENTIONAL LED SYSTEMS.
- PWM IS PROVEN TECHNOLOGY.
- LOWER OPERATING VOLTAGE.
- EXISTING PHYSICAL INFRASTRUCTURE (CANS & CONDUIT) IS PROVEN RELIABLE SYSTEM.



SYSTEM RELIABILITY

Orlando International Airport (MCO) Airfield Lighting Inspection

Date: Wednesday, 09 September 10

Runway	(E) Edge (W)	Centerline	Touchdown	Threshold	Windsocks
18L/36R	/	4	/	/	/
18R/36L	/ /	3	/	/	/
17L/35R	/ /		/	/	/
17R/35L	/	2	/ /	/	/

In Pavement Runway Guard Lights – Hold Bars for Runway 18L/36R

B1(e)	B1(w)	ILS	B2	B5	B6	B7	B9	B10(e)	B10(w)	E(e)	E(w)	J(e)	J(w)	Y
				1	3	1						2	1	1

In Pavement Runway Guard Lights - Hold Bars for Runway 18R/36L

A1	A2	A3	B1	ILS	B10	E (e)	E (w)	J(e)	J(w)	Y
								2	1	2

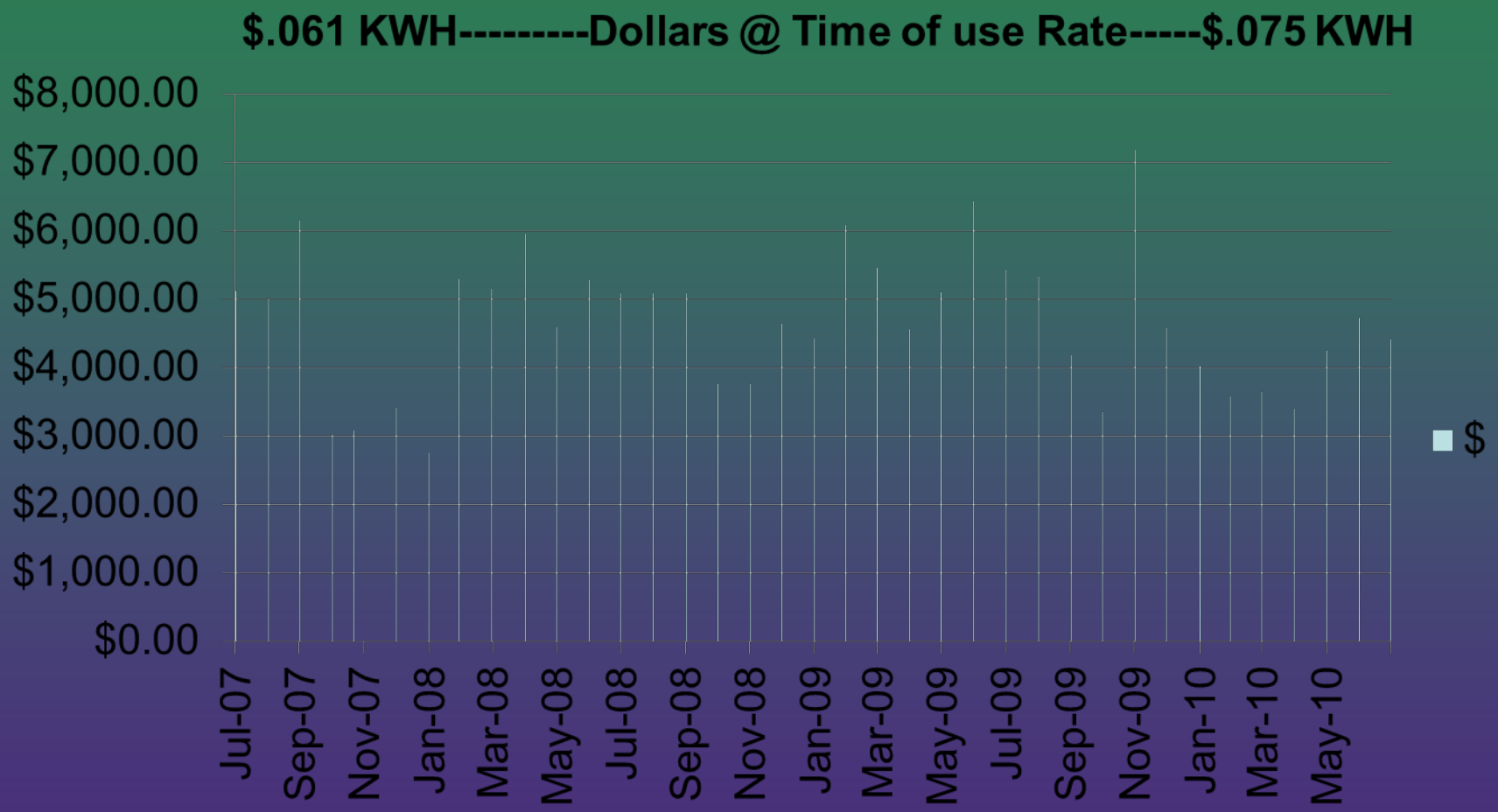
In Pavement Runway Guard Lights - Hold Bars for Runway 17R/35L

H1	H2	H3	H5	H6	H7	H8	H9	H10	K	ILS	E(e)	E(w)	F(e)	F(w)
			1											

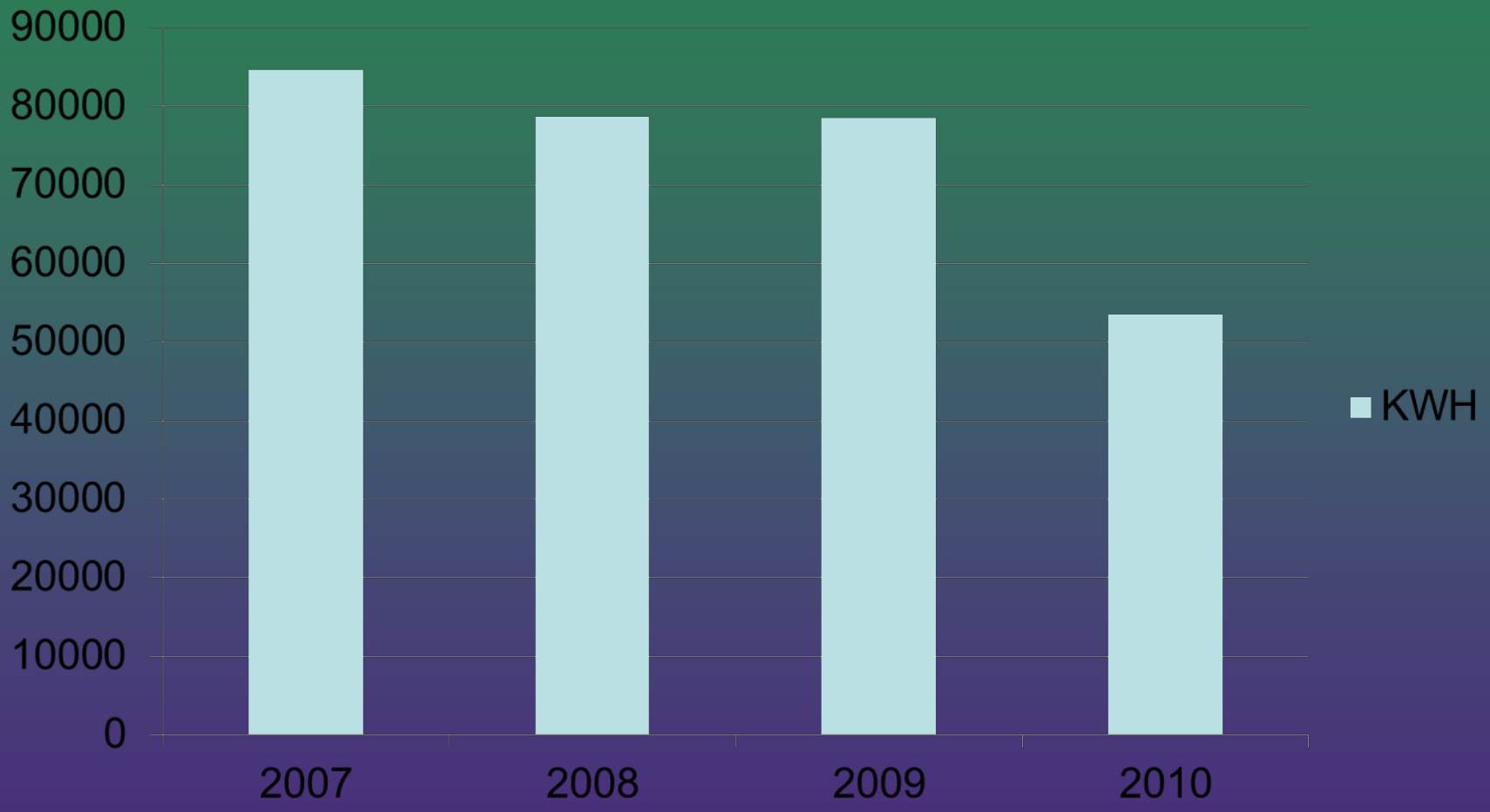
In Pavement Runway Guard Lights - Hold Bars for Runway 17L/35R

F	J	N1	N2	N3	N4	N5	N6
			1	1	1	1	

SYSTEM COST PER MONTH



MONTHLY AVERAGE KWH USAGE



THANK YOU FOR YOUR HELP PUTTING THE DEMONSTRATION PROJECT TOGETHER:

- Carlos Castillo – GOAA
- Glen Quick – GOAA
- Mark Goodacre – AVCON, INC.
- Meghann Kriss – AVCON, INC.
- Stan Reiber – GOAA
- Sue Finney- AVCON, INC.
- Will Rogers - GOAA
- Ed Runyon – ADB
- Miguel Vasquez-Lavado - ADB

GREATER ORLANDO
AVIATION AUTHORITY

AVCON

IESALC Illuminating Engineering Society of North America Aviation Lighting Committee

DC POWERED LED TAXIWAY CENTERLINE LIGHTING SYSTEM: A CASE STUDY

Presented to:

IES ALC Fall Conference 2010

by:
Frank Barczak
Jeff Pace
Carl Johnson

GREATER ORLANDO AVIATION AUTHORITY

AVCON

REVISED 10/9/10