IESALC Illuminating Engineering Society of North America Aviation Lighting Committee

DC POWERED LED TAXIWAY CENTERLINE LIGHTING SYSTEM: A CASE STUDY

Presented to:

2011 *IES Aviation Lighting Committee*
Fall Conference
Wilmington, North Carolina

2011-IESALC
Wilmington, NC

by:

Frank Barczak
Jeff Pace

GREATER ORLANDO AVIATION AUTHORITY

AVCON


WELCOME TO
Orlando
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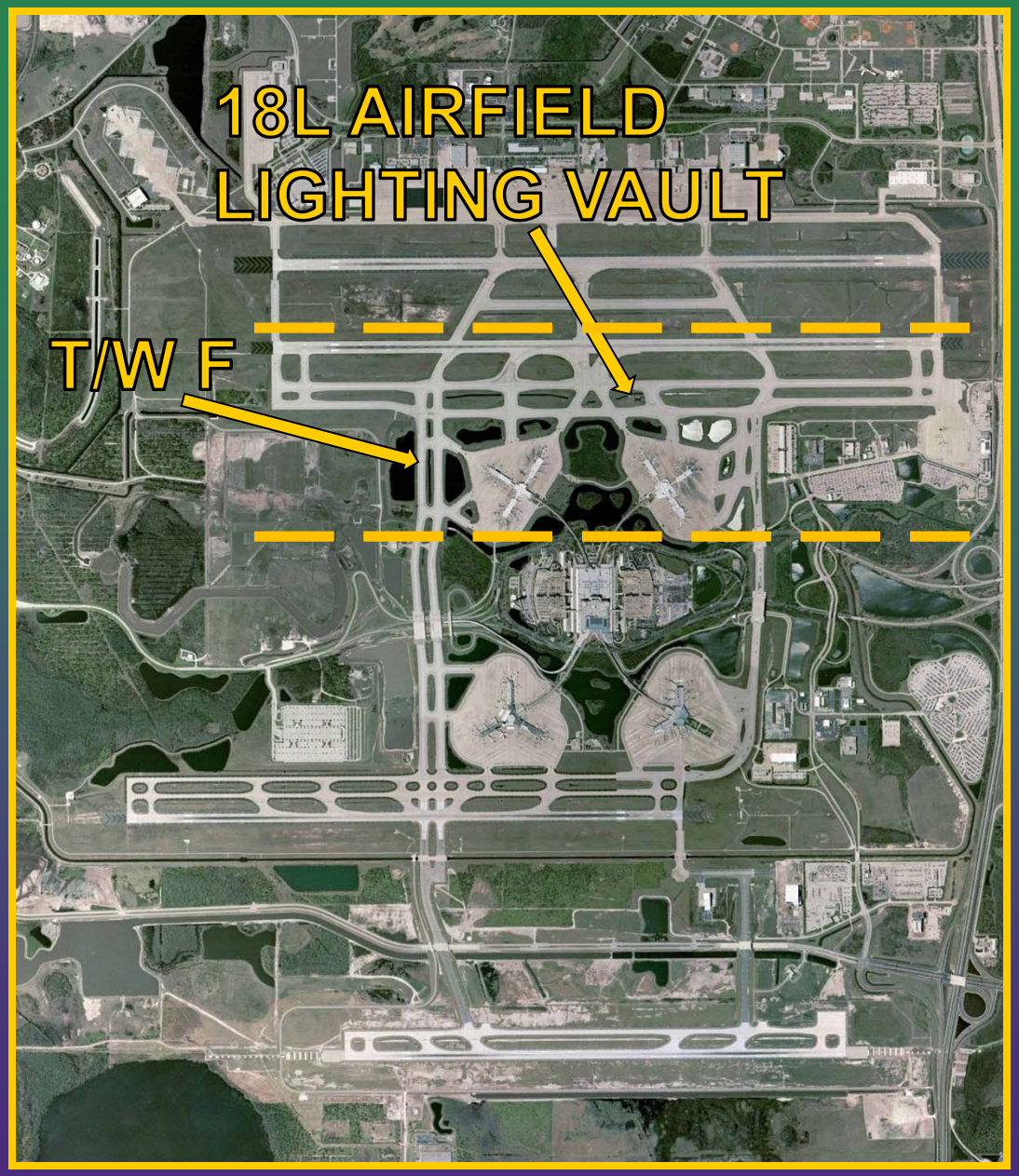
Bienvenido • Welkom • Saudacão Amável • Benvenuto



North

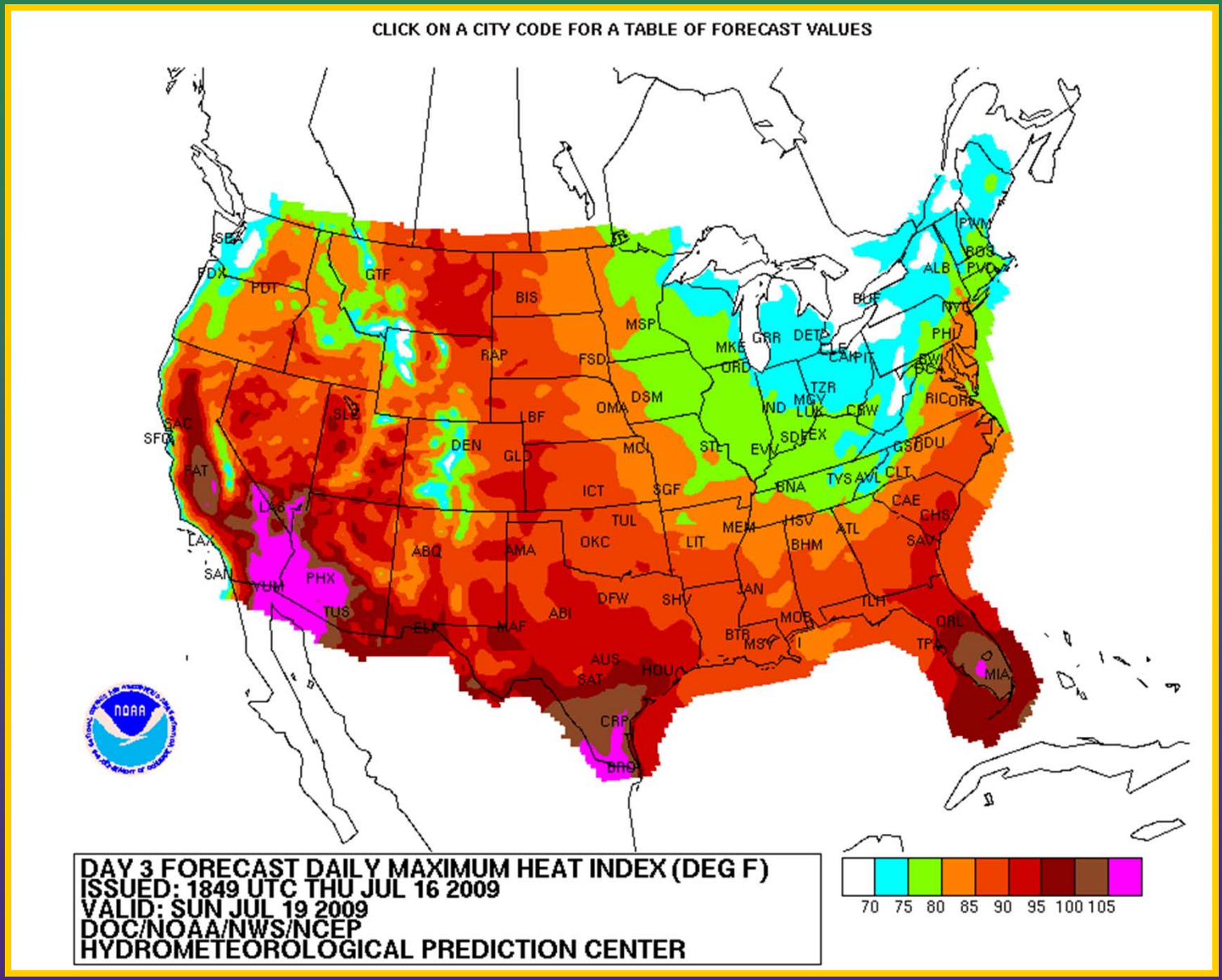
ORLANDO INTERNATIONAL AIRPORT


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"

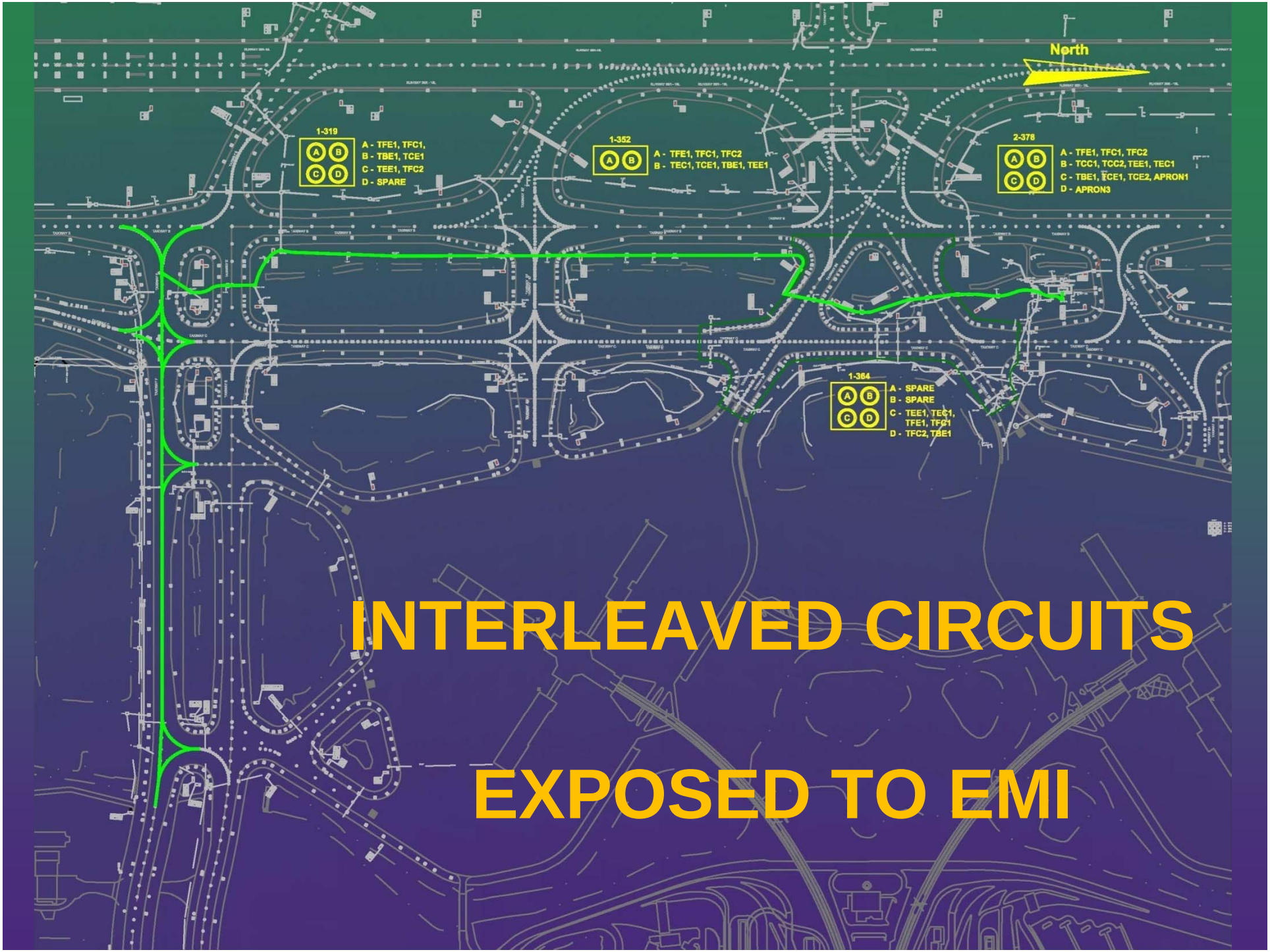
WHY OIA?

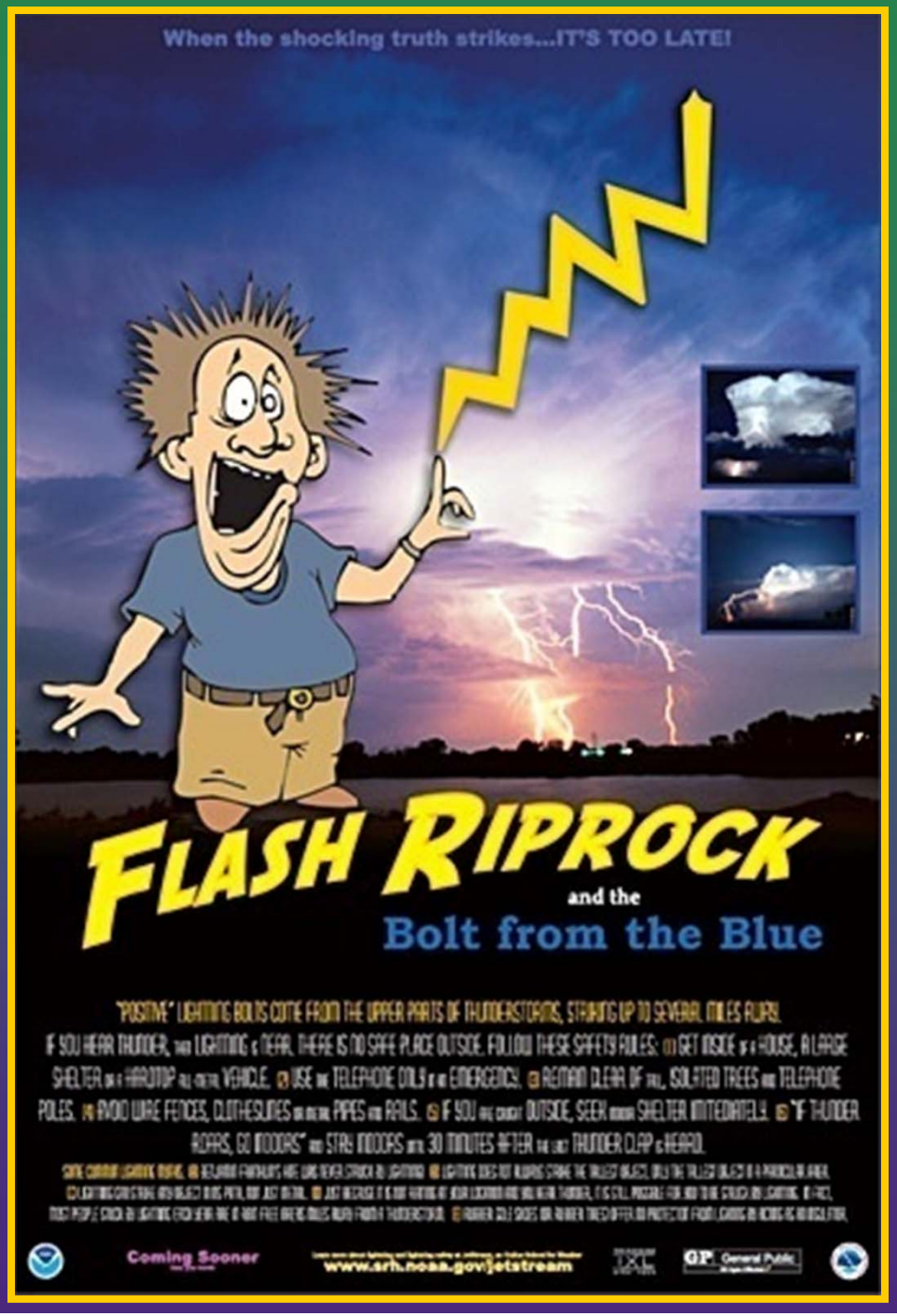
HIGH GROUND WATER

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

LIGHTNING

EXISTING CIRCUIT

- TFC1 CIRCUIT IS POWERED FROM THE 18L AIRFIELD LIGHTING VAULT.
- TFC1 CONSISTS OF 116 TAXIWAY CENTERLINE LED FIXTURES AND INCLUDES 22,000 FEET OF L-824 5 KV CABLE.

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.


R1

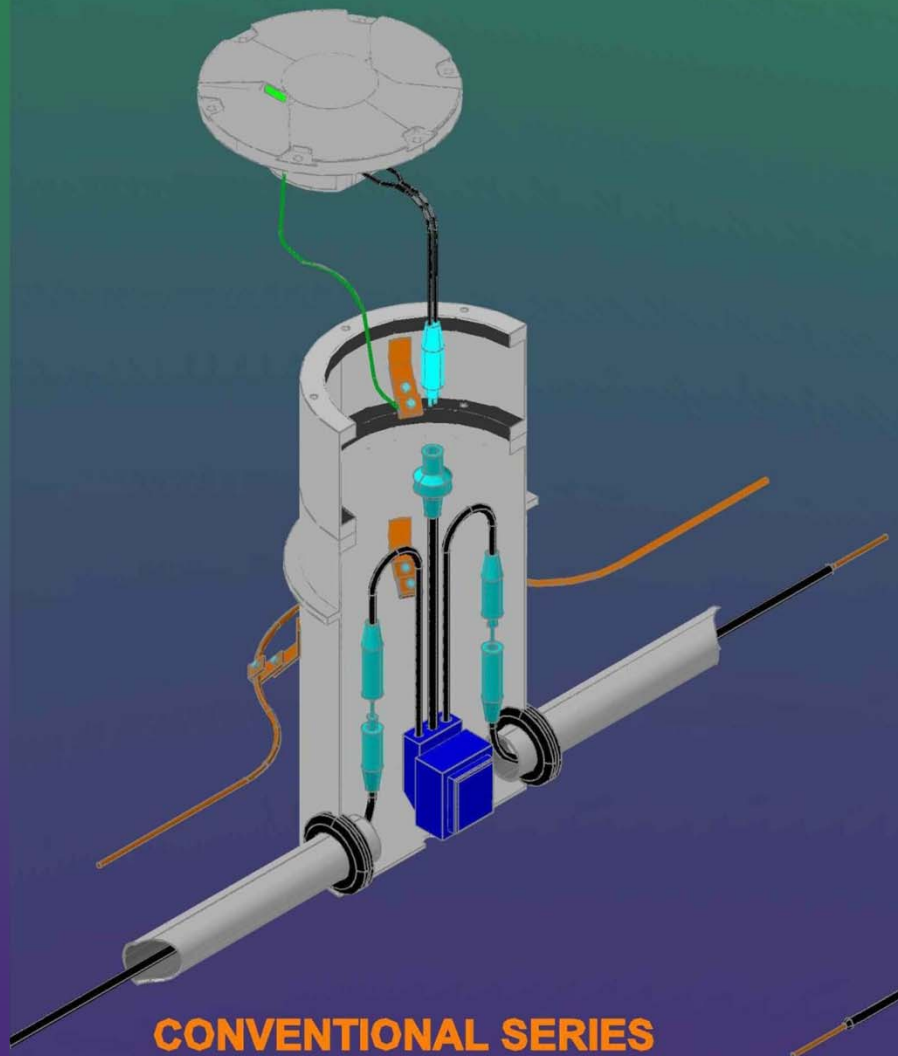
Date	Time	TFC1 Step	TFC2 Step	Input KW	
				TFC1	TFC2
9/29/11	18:48:45	0	1		.867
9/30/11	00:42:25	5	5	1.661	4.612
9/30/11	01:51:45	0	1		.867
9/30/11	06:53:38	0	0		
9/30/11	18:34:45	1	0	.088	
10/1/11	01:22:52	5	5	1.661	4.612
10/1/11	01:22:54	3	0	.101	
10/1/11	01:25:55	5	5	1.661	4.612
10/1/11	02:34:02	1	0	.088	
10/1/11	06:51:04	0	0		
10/1/11	18:55:42	1	0	.088	
10/2/11	06:50:25	0	0		

GOALS OF DC SYSTEM

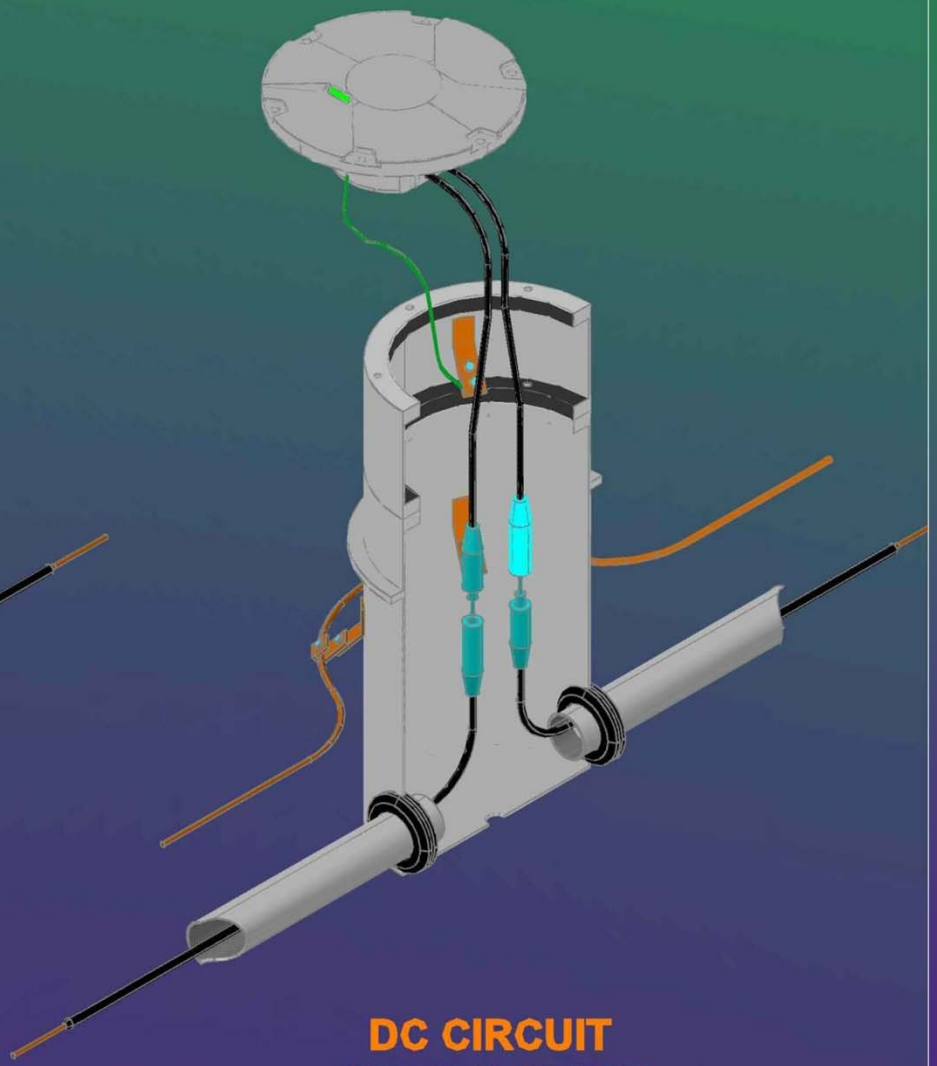
- MAXIMIZE USE OF EXISTING ELECTRICAL INFRASTRUCTURE.
- MINIMUM SYSTEM COMPLEXITY.
- IMPROVED SAFETY.
- MAXIMUM ENERGY EFFICIENCY.
- SYSTEM RELIABILITY.

EXISTING INFRASTRUCTURE

SIDE BY SIDE COMPARISON

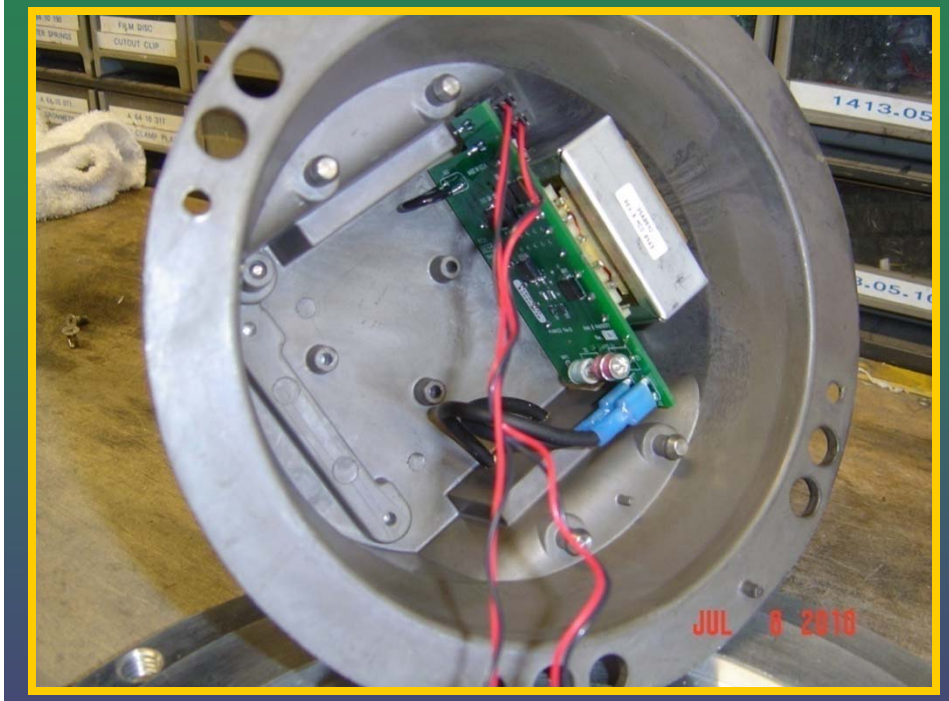


CONVENTIONAL SERIES CIRCUIT INSTALLATION



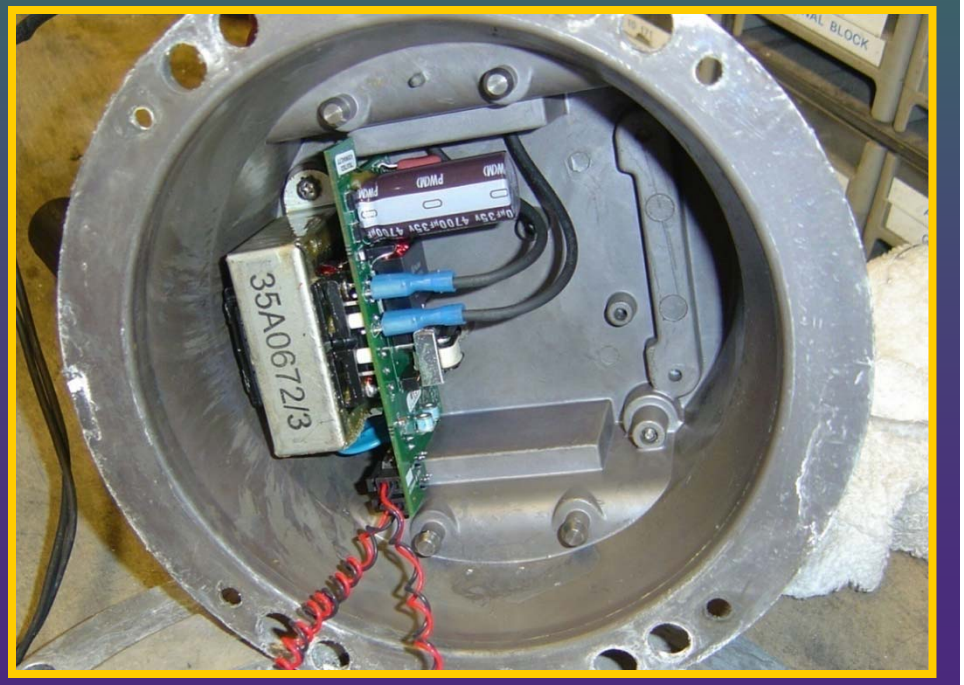
DC CIRCUIT INSTALLATION

MINIMUM SYSTEM COMPLEXITY



DC LED FIXTURE

STANDARD
LED FIXTURE



MINIMUM SYSTEM COMPLEXITY

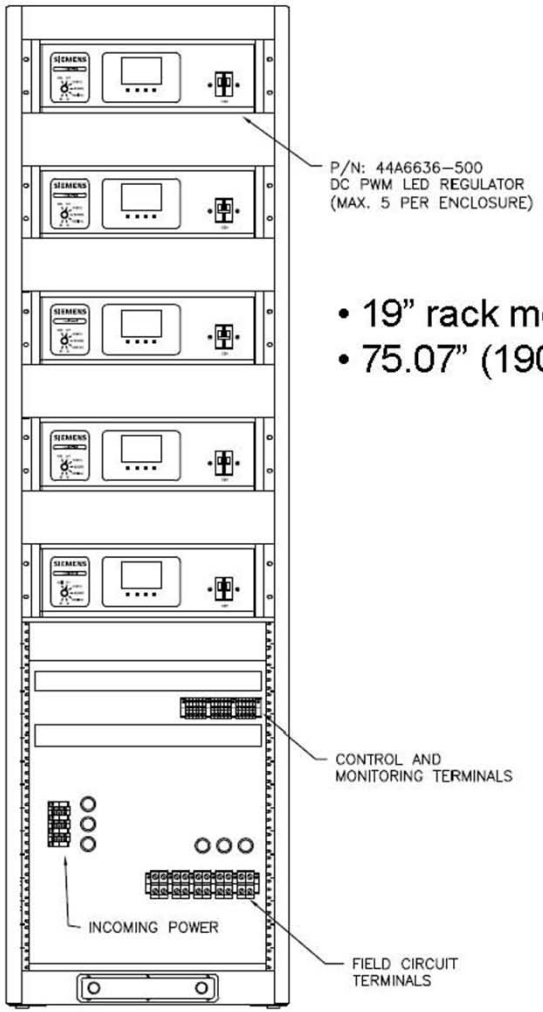
PULSE WIDTH MODULATION (PWM):

- **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.**

MINIMUM SYSTEM COMPLEXITY

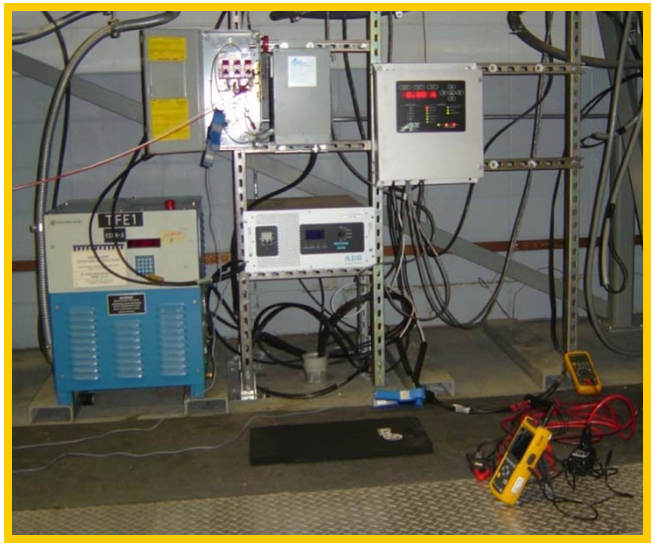
- THE POWER SUPPLY IS SMALL, 19” RACK MOUNT.
- MULTIPLE POWER SUPPLIES CAN BE INSTALLED IN THE SAME VOLUME AS A CONVENTIONAL CCR.
- 3-STEP OR 5-STEP.

MINIMUM SYSTEM COMPLEXITY

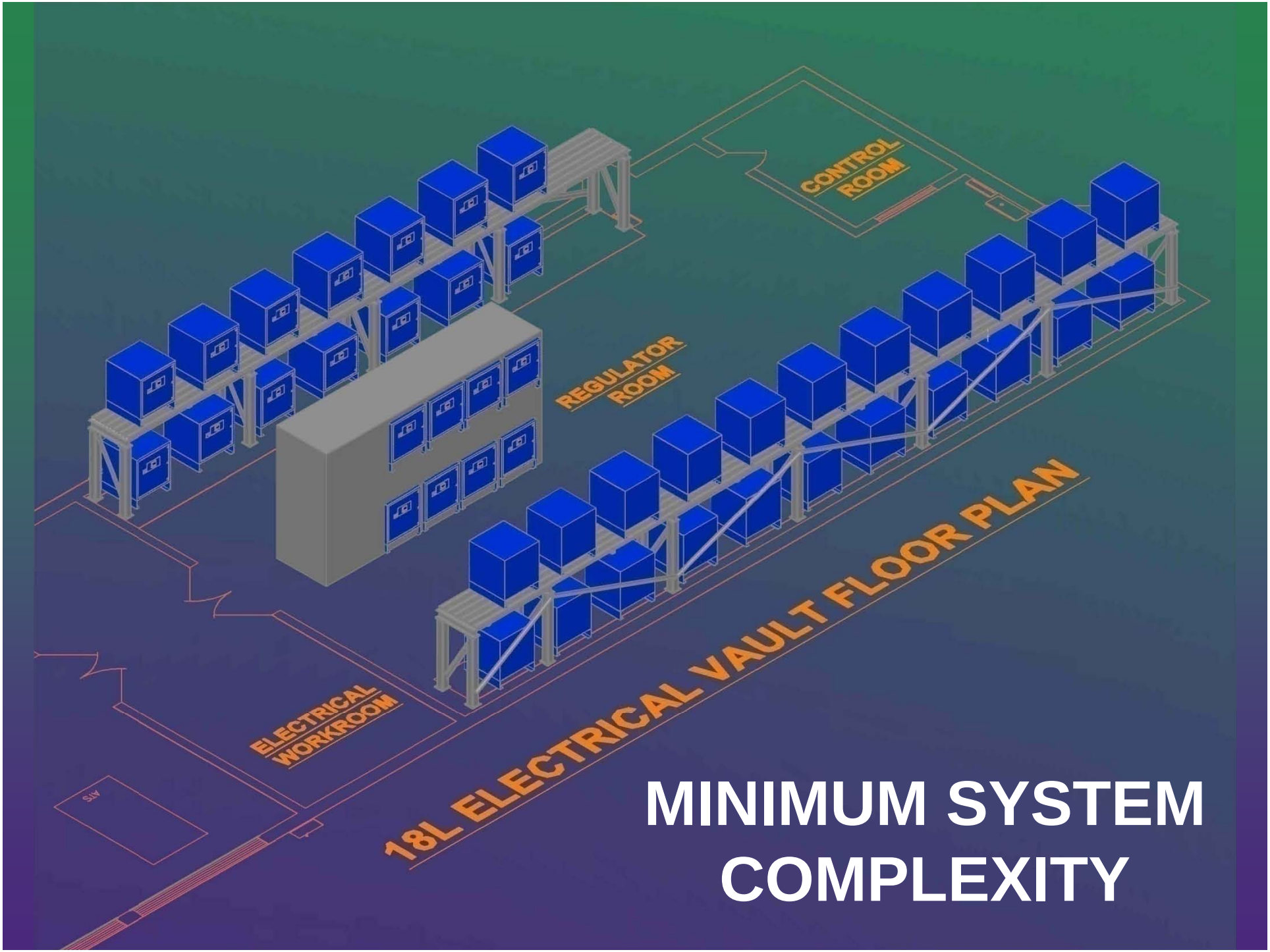


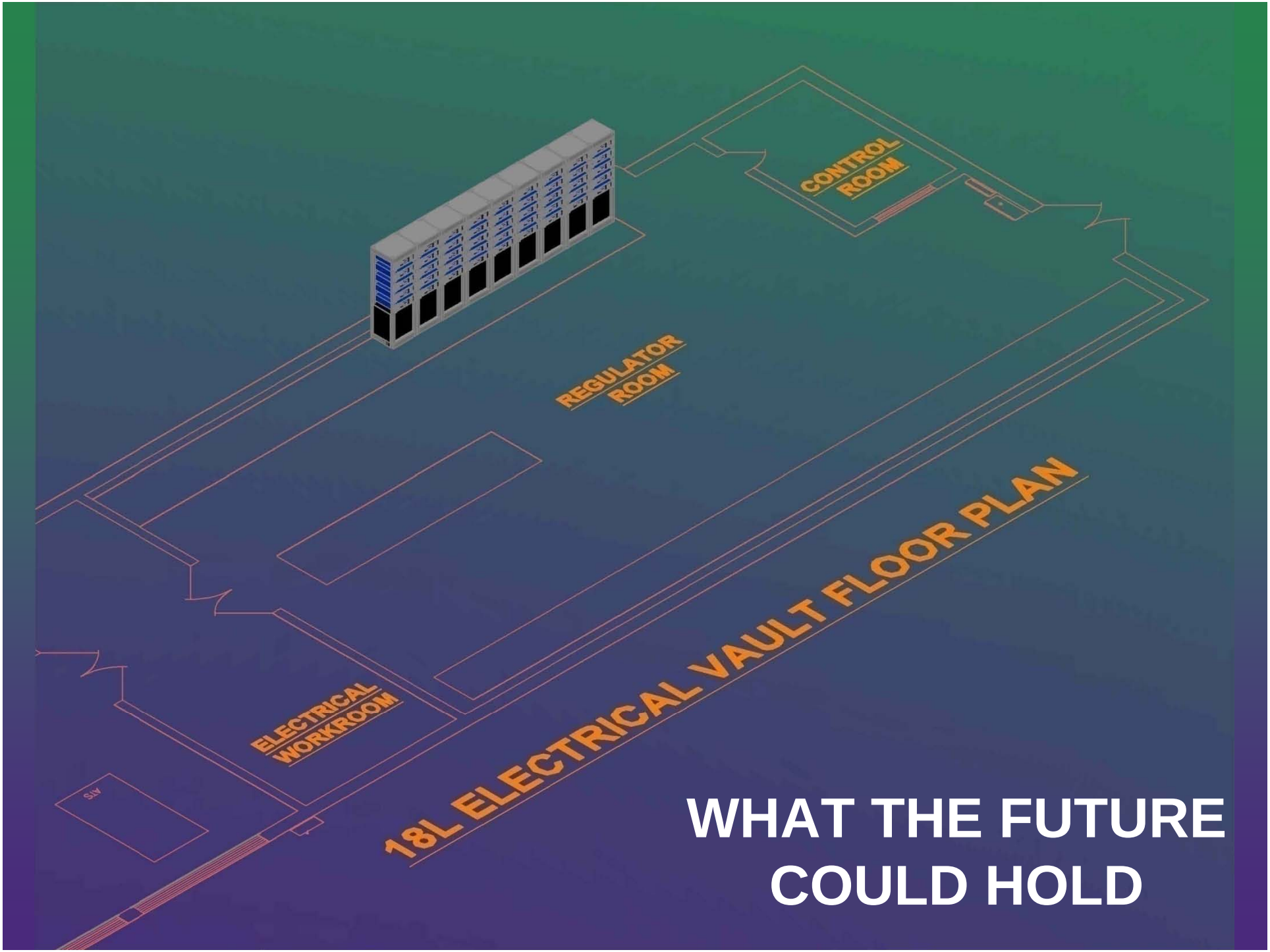
Example APS Installation

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



MINIMUM SYSTEM COMPLEXITY

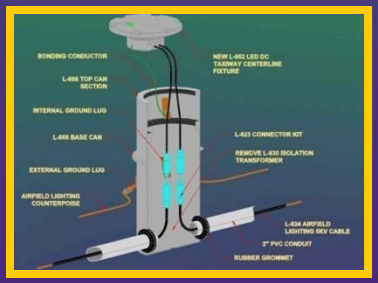

CONTROL ROOM
REGULATOR ROOM
ELECTRICAL WORKROOM
18L ELECTRICAL VAULT FLOOR PLAN
MINIMUM SYSTEM COMPLEXITY



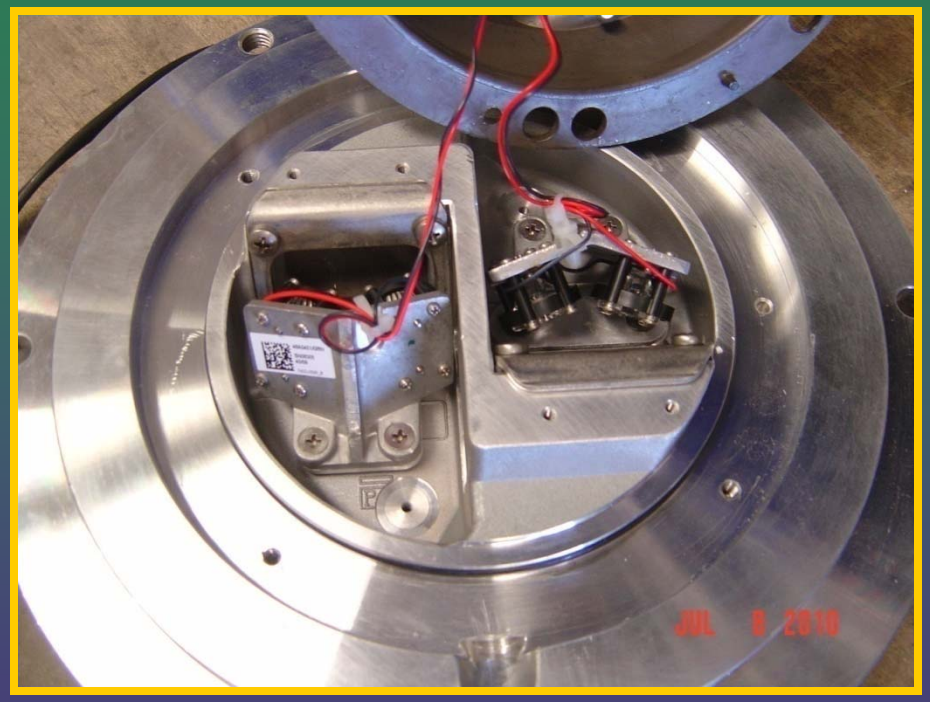
WHAT THE FUTURE COULD HOLD

IMPROVED SAFETY

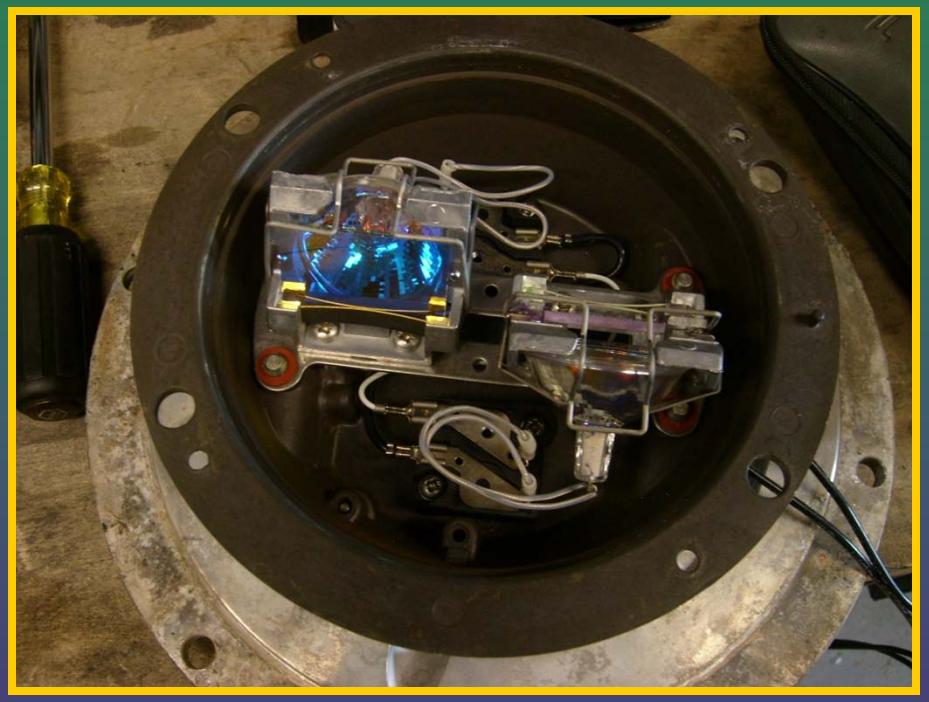
- THE MAXIMUM OUTPUT VOLTAGE FOR A 1 KW POWER SUPPLY IS 500 VOLTS.
- THE MAXIMUM OUTPUT VOLTAGE FOR A 2 KW POWER SUPPLY IS 1,000 VOLTS.
- NEW DC SYSTEM IS SIMILAR TO EXISTING SERIES CIRCUIT. TROUBLESHOOTING METHODS ARE SIMILAR. AIRFIELD ELECTRICIANS ARE FAMILIAR WITH SERIES CIRCUIT OPERATION.



MAXIMUM ENERGY EFFICIENCY

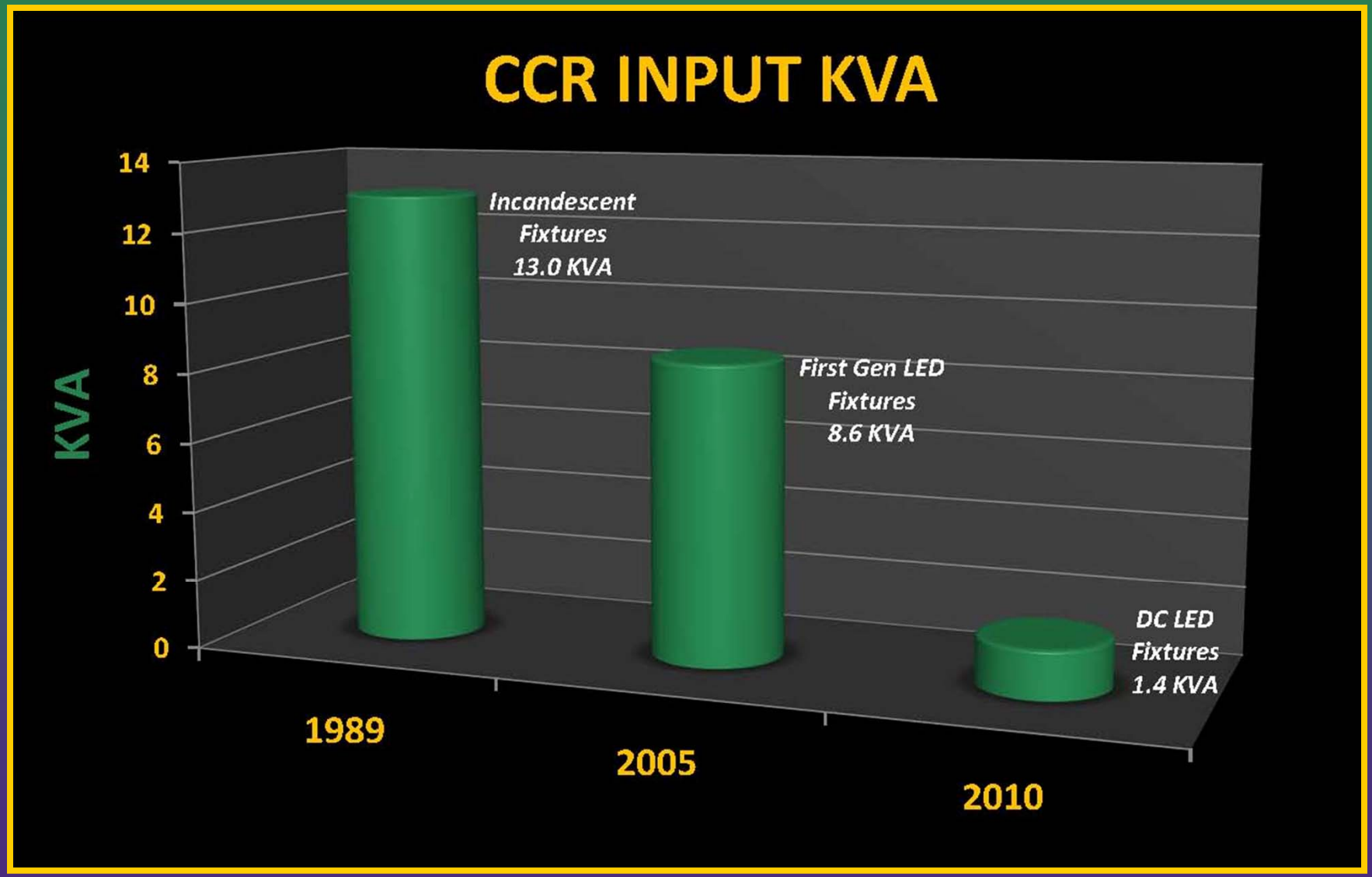


DC LED L-852D
10.2 WATTS



INCANDESCENT L-852D
60 WATTS

MAXIMUM ENERGY EFFICIENCY



ROI System Parameters

- **Number of Fixtures** **116**
- **Energy Price per kWH** **$0.12**
- **Average Operating Time per year in hours** **2628**
- **Based on operation for 12 hrs./day over the course of 1 year. Interleaved circuit, TFC1 is energized 50% of the time & TFC2 is energized 50% of the time. Assume bad weather requires both circuits to be operated simultaneously 10% of the time. Use 60% of 12 hr./day*365 days per year for calculations.**

Return on Investment

System Factors	APS LED	Incandescent	Cost (Savings)	Comments
Capital Equipment Cost-Power Supply	$9,000.00	$9,000.00	$0.00	Investment differential for the circuit power supply.
Fixture Purchase Cost	$600.00	$400.00	$200.00	Investment differential for each fixture.
Capital Equipment Cost-Isolation Transformer	$0.00	$80.00	($80.00)	Investment differential for fixture isolation transformer.
Total of Capital Equipment Investment			**$13,920.00**	
Energy Costs and Savings			Savings (Cost)	
Power Supply Size Used (Watts)	2,000	10,000		
Average Fixture Load (VA)	4.9	30		
Average Isolation Transformer load (VA)	0	4.5	140	This figure is for heating losses for the isolation transformer. For the APS LED, no isolation transformer is used.
				140 The Incandescent load is entered as follows: For a bi-directional 2 x 30W fixture, using one 65W isolation transformer, this is 13/2=6.5VA.
Total Energy Savings (or Costs) per year	$305.39	$1,892.79	**$1,587.40**	

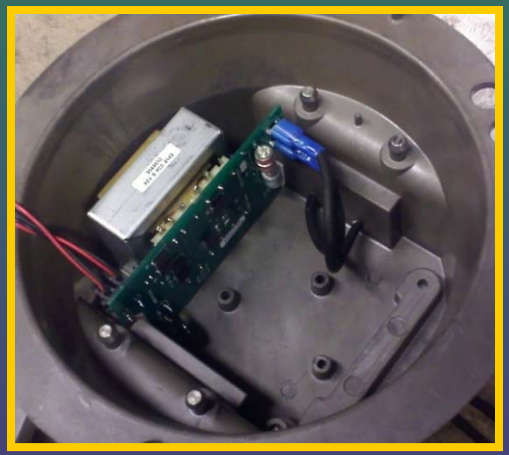
Return on Investment

Maintenance Cost	APS LED	Incandescent	Cost (Savings)	
Average Replacement Lamp Cost	$0.00	$40.00		
Average Replace Lamp Labor; Fuel Cost; Coordinate Airfield Closure per Fixture	$0.00	$35.00		Industry average cost by customer survey to replace Incandescent lamps.
Average lamp replacements per year	0	2		Incandescent Industry Average by Customer Survey.
Routine Maintenance Cost per year	$0.00	$17,400.00	$17,400.00	
Total Energy Savings per year	$305.39	$1,892.79	$1,587.40	
Total Yearly Savings			$18,987.00	
On Total Investment of			$13,920.00	
APPS LED Return on Investment (ROI)			**0.073**	**Years**
Fixture Lifetime (years) - 15			Cost (Savings)	Life Cycle Cost
Total System Acquisition Cost	$78,600.00	$64,680.00	$13,920.00	Includes power-supply cost plus total of fixtures and transformer costs.
Installation Cost	$0.00	$0.00	$0.00	
Total Operating Cost (energy)	$4,580.85	$28,391.85	**($23,811.00)**	Energy price per kWH is assumed to remain unchanged
Routine Maintenance Cost (light-source + labor only)	$0.00	$261,000.00	**($261,000.00)**	Based on routine replacements of light-sources plus labor costs over lifetime of all fixtures.
Total Life Cycle Cost	$83,180.85	$354,071.85	**($270,891.00)**	

After 15 years, the total estimated reduction of emissions is 97.5 metric tons of CO2, or about one year's worth of emissions from 18 vehicles or 8.3 to 11.9 homes.

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.



Airport Improvement: September, 2011

Orlando Int'l Maximizes Taxiway Lighting Efficiency with Advanced Power Supply System

By Robert **Nordstrom**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