

Applying GIS Technology to Arc Flash Study at BWI Thurgood Marshall Airport

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Presentation Overview

– Arc Flash Study at BWI Thurgood Marshall Airport

- Arc Flash
- Arc Flash Labelling

– GIS

– GIS application for our study

An aerial photograph of the Baltimore-Washington International Thurgood Marshall Airport. The image shows the large, modern terminal building with its distinctive curved roof and multiple concourses. Numerous commercial aircraft are parked at the gates, and many jet bridges are extended. The surrounding area includes parking lots, taxiways, and runways. The text "Arc Flash Study at Baltimore-Washington International Thurgood Marshall Airport" is overlaid in large white letters across the center of the image.

Arc Flash Study at Baltimore-Washington International Thurgood Marshall Airport

Arc Flash Study at Baltimore-Washington International Thurgood Marshall Airport

– Maryland Aviation Administration (MAA)



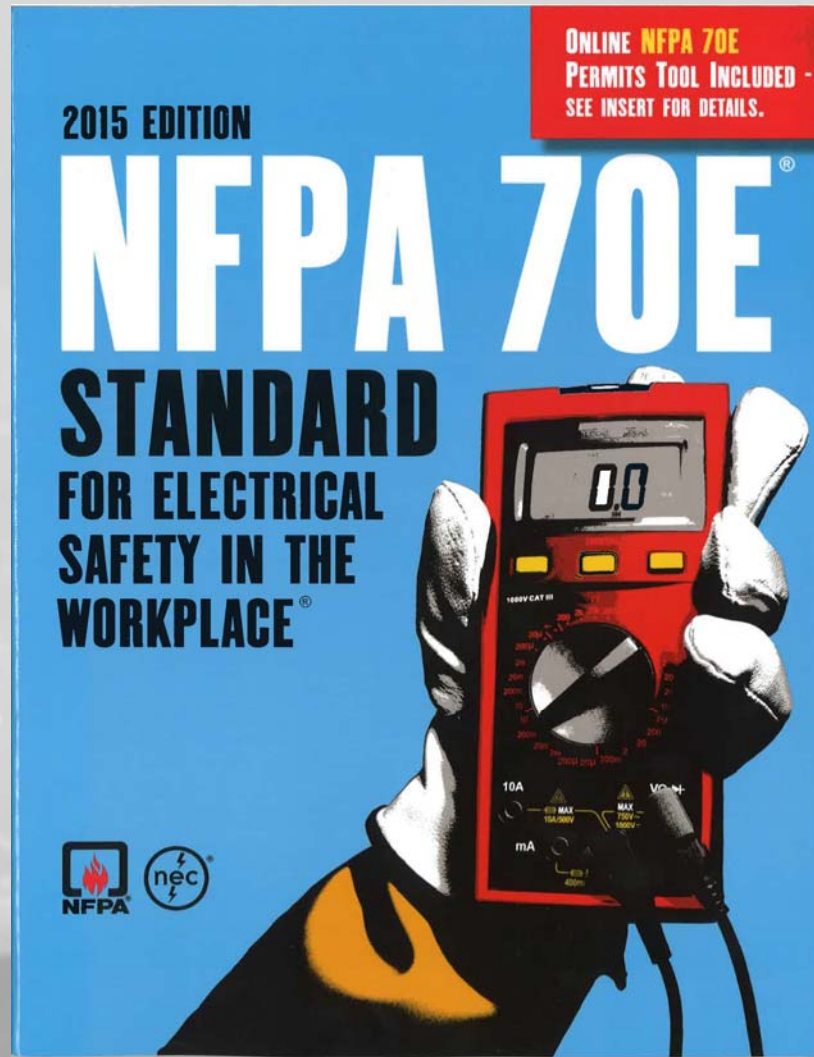
– AECOM



– Baltimore-Washington International
Thurgood Marshall Airport



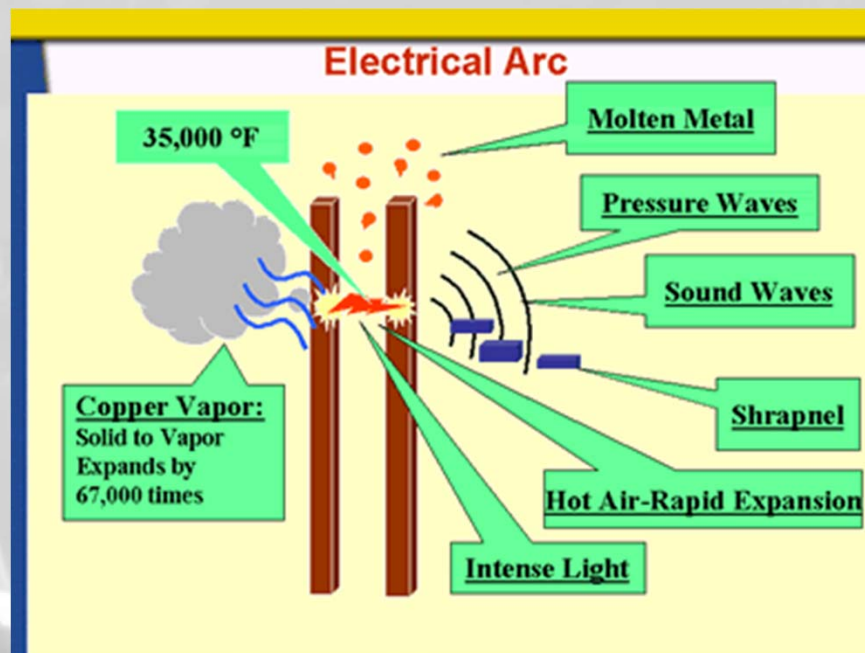
What is Arc Flash?



What is Arc Flash?

–NFPA 70E-2015 Article 100. Arc Flash Hazard

- A dangerous condition associated with the possible release of energy caused by an electric arc



What electrical tasks at an airport may cause Arc Flash?

- Per NFPA 70E Table 130.7(C)(15)(A)(a)
- Work on energized electrical conductors and circuit parts, including voltage testing
- Removal or installation of circuit breakers or switches



What tasks at an airport may cause Arc Flash?

- Removal of bolted covers (to expose bare energized electrical conductors and circuit parts)
- Open hinged doors or covers (to expose bare energized electrical conductors and circuit parts)
- Insertion or removal of individual starter buckets from motor control center (MCC)



What tasks at an airport may cause Arc Flash?

- Insertion or removal of plug-in devices into or from busways



- In general, electrical tasks involve any exposed energized electrical component.

Standards Covering Arc Flash

NFPA 70E Standard For Electrical Safety in the Workplace

Occupational Safety and Health Administration (OSHA)

- OSHA 29 CFR Part 1910

Institute of Electrical and Electronics Engineers (IEEE)

- IEEE standard 1584

NFPA 70 National Electrical Code (NEC)

- NEC 110.16 Flash Protection

U.S. Bureau of Labor Statistics

- 2,000 fatal and 24,000 non-fatal electrical injuries from an arc flash in the last 10 years.
- Over 2,000 people admitted to burn centers yearly with severe arc flash burns
- 80% of electrically related accidents, incidents and fatalities among qualified workers are caused by arc flash



De-energized Equipment

- The most effective way to eliminate the risk of electrical shock or arc flash is to simply de-energize the equipment

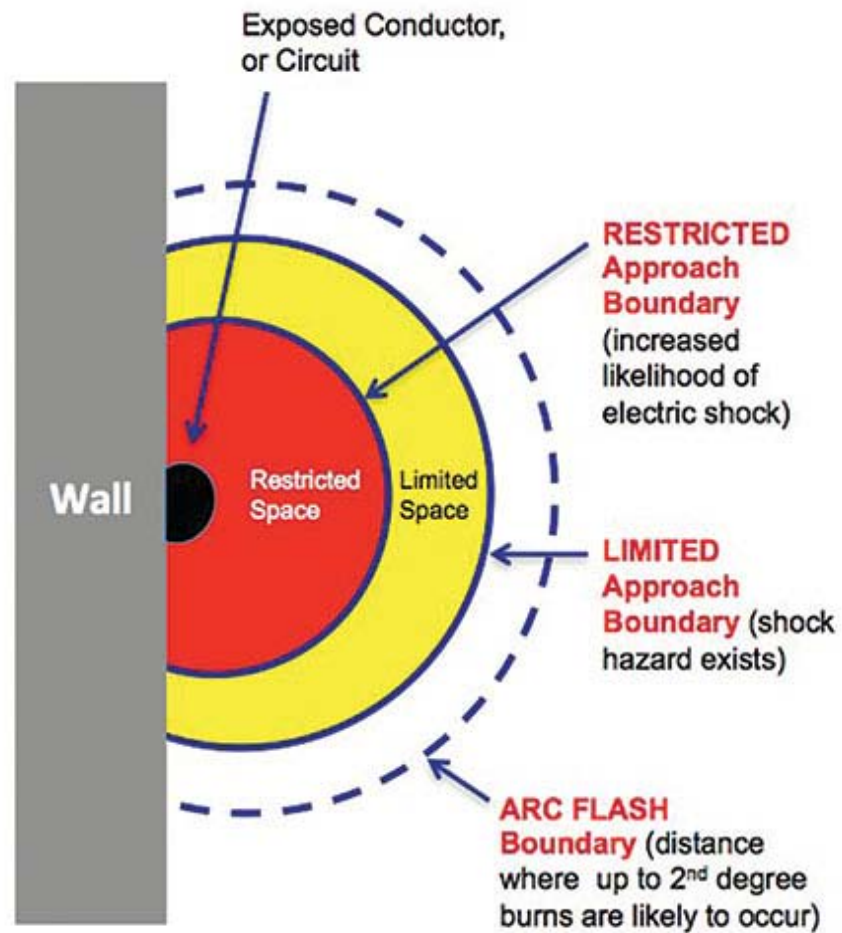


Arc flash released incident energy

- Incident energy expressed in cal/cm^2
- 1 cal/cm^2 energy approximately equal to hottest part of lighter in 1 sec
- **1.2 cal/cm^2** exposure will cause **second degree burns** on human skin



Arc flash Boundary Definitions in NFPA 70E - 2015



2015 Arc Flash Boundaries

Selection of PPE

- Arc Flash PPE Categories Method
- Incident Energy Analysis Method

Selection of PPE

Arc Flash PPE Categories Method

- NFPA Tables: NFPA 70E – 2015
 - Tables 130.7(C)(15)(A) and (B)
 - Table 130.7(C)(16)
 - Voltage rating
 - Maximum available short-circuit current
- Pro: Easiest and quickest
- Con: Provides the least amount of accuracy. Limited equipment are listed in tables.

Selection of PPE

Incident Energy Analysis Method



- Electrical modeling
- Pro: More accurate result
- Con: Cost and time



Arc Flash Label

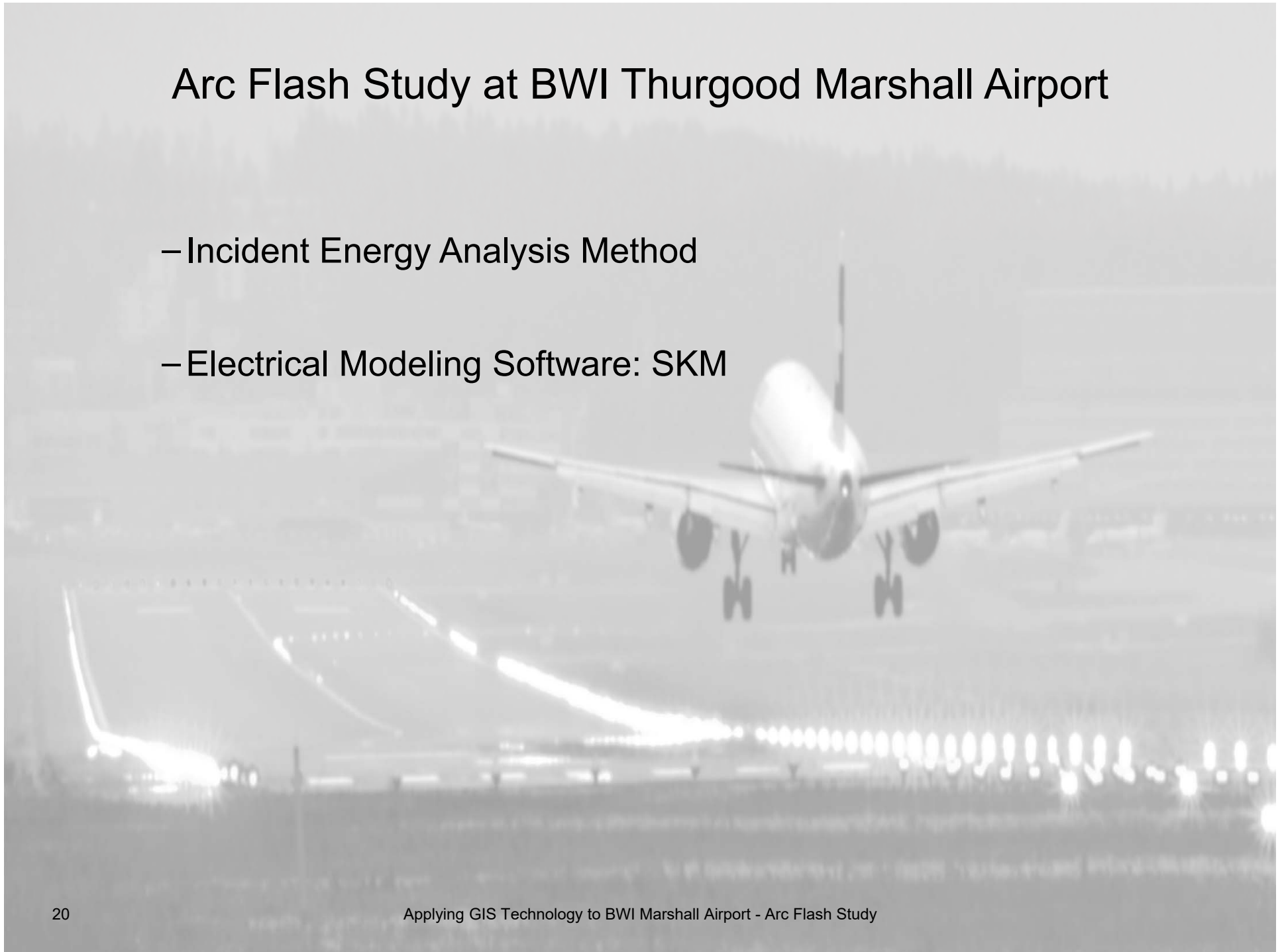
- Equipment ID (name)
- Nominal system voltage
- Arc flash boundary
- One of the following (**Not Both**):
 1. Available incident energy and the corresponding working distance
(Minimum arc rating of clothing required)
 2. Arc flash PPE category from NFPA -70E Tables

Arc Flash Protection Label

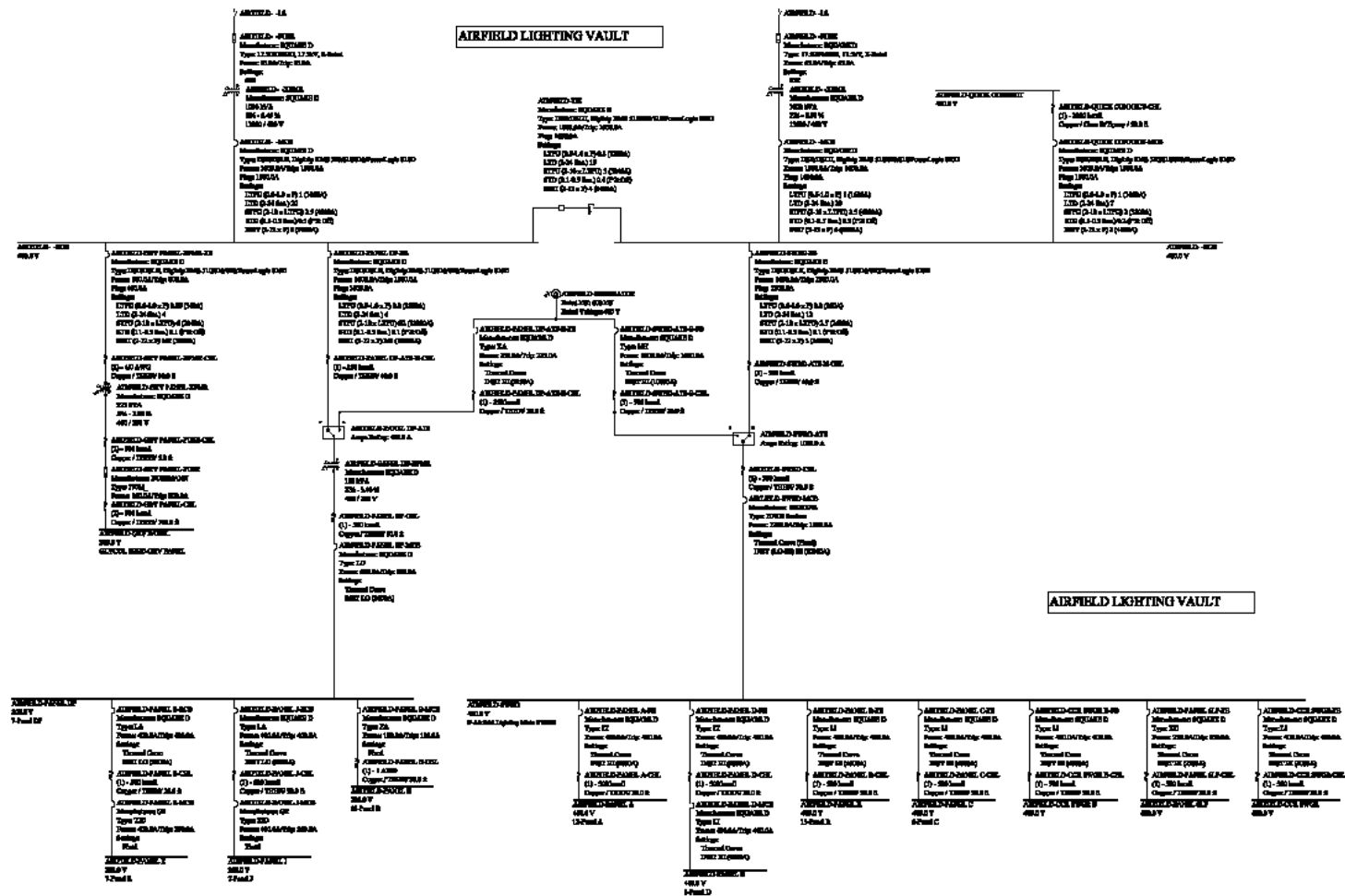
 WARNING	
	ARC FLASH & SHOCK HAZARD APPROPRIATE PPE REQUIRED
12.66 in	Arc Flash Hazard Boundary
0.71 cal/cm²	Arc Flash Hazard at 18 in
	Arc Rated Clothing Required
	(See NFPA 70E-2015 H.3(b) for Additional PPE)
480 VAC	Nominal System Voltage
42 in	Limited Approach Boundary
12 in	Restricted Approach Boundary
Equipment ID: CORP-PP	
ARCGIS ID: CORPORATE HANGAR 501-PP	
Location/MAATask #: MTN / 4428	Date of Analysis: 04/18/2017

Arc Flash Study at BWI Thurgood Marshall Airport

- Incident Energy Analysis Method
- Electrical Modeling Software: SKM



SKM Single Line Model – Airfield Lighting Substation



Information needed for SKM Modeling

- Available fault current of power source from utility company



- switchgear/switchboard information



Information needed for SKM Modeling

–transformer information



–panelboard information

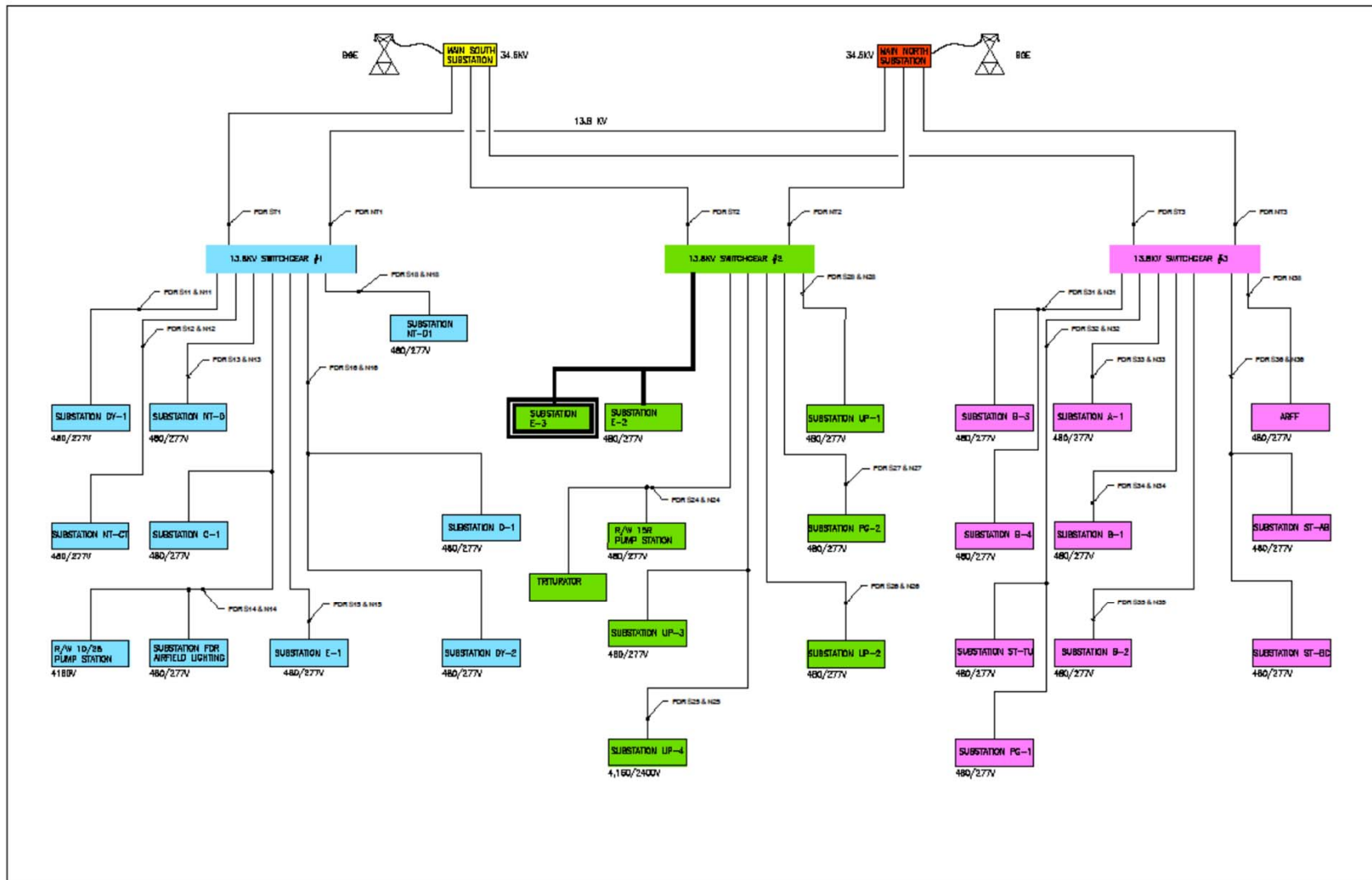


–feeder information

–Connection between electrical equipment.

–(The most difficult task)

Existing Electrical Power Distribution System at BWI Thurgood Marshall Airport



Friendship International Airport 1950



Baltimore Washington International Airport 1972

Substations ST-AB, NT-CT, NT-D



Terminal D Extension 1983

Substation D-1



Terminal DY Extension 1988

Substations DY-1 and DY-2



Hourly Garage 1991

Substation PG-1



Terminal C Extension 1994

Substation C-1



Terminal B Extension/Parking Garage Addition 1998

Substations B-3, B-4, PG-1 (Expansion)



International Terminal (Pier E) 1999

Substations E-1, E-2



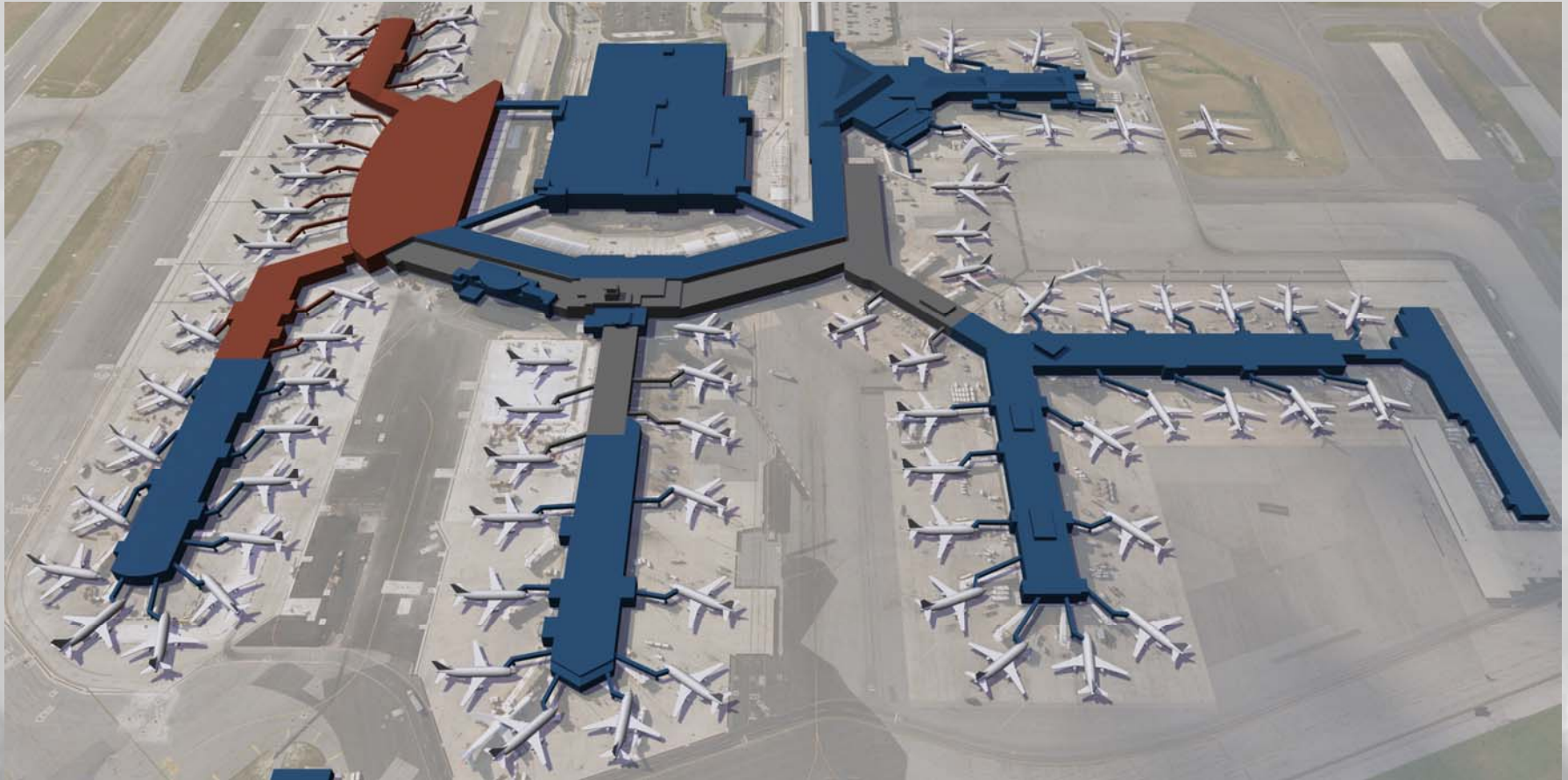
Terminal Curbside Expansion & Skywalks 2004

Substation ST-TU



Terminal A/B Expansion 2005

Substations A-1, B-1, B-2



DE Baggage System Claim Improvement (DEBSCI) 2010

Major Modification to Substation E-1



B/C Connector 2013

Substation ST-BC



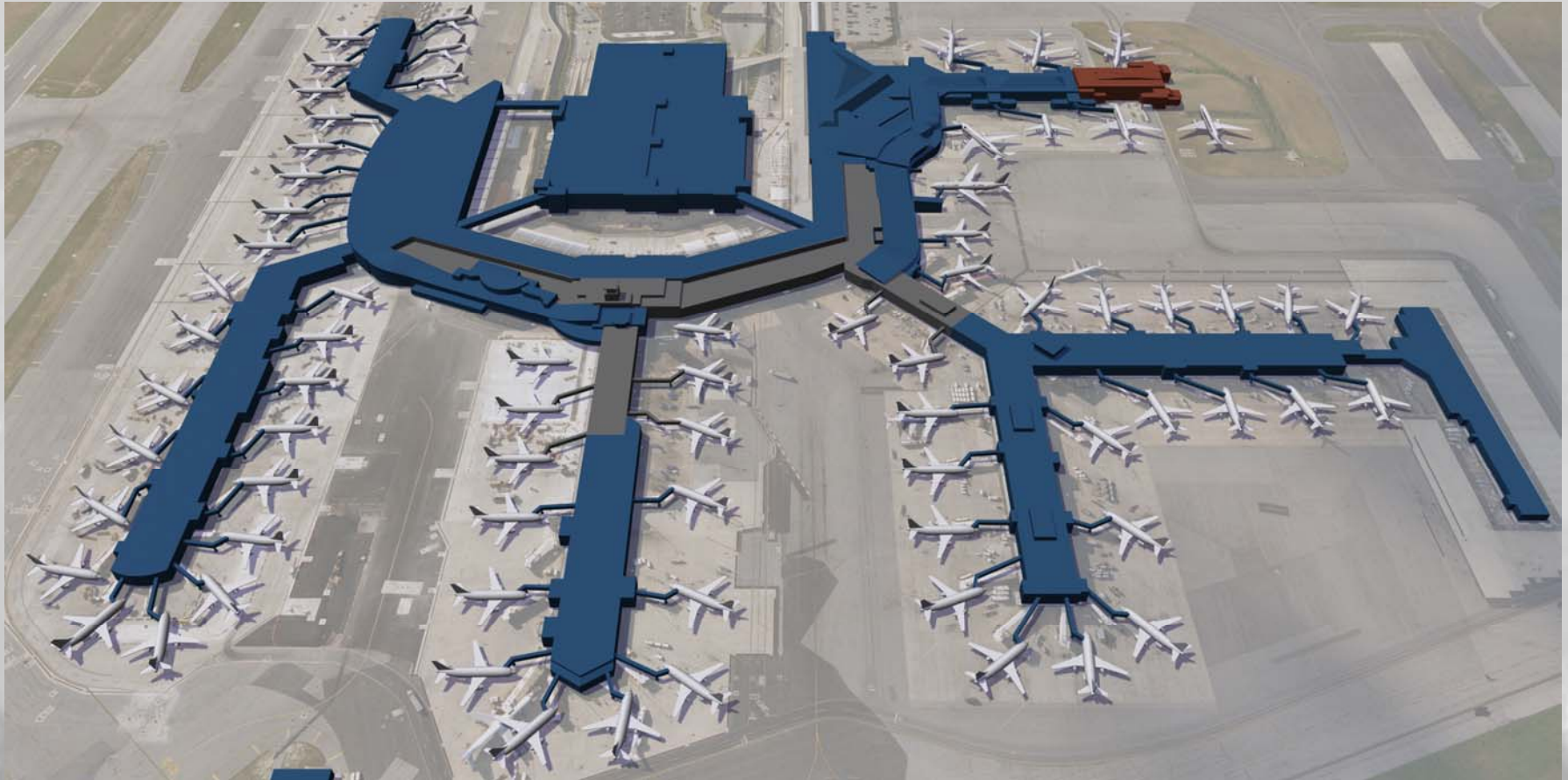
D/E Connector 2016

Substation NT-D1



Concourse E Extension 2017

Substation E-3



Baltimore Washington International Airport 1972

Substations ST-AB, NT-CT, NT-D



Terminal D Extension 1983

Substation D-1



Terminal DY Extension 1988

Substations DY-1 and DY-2



Hourly Garage 1991

Substation PG-1



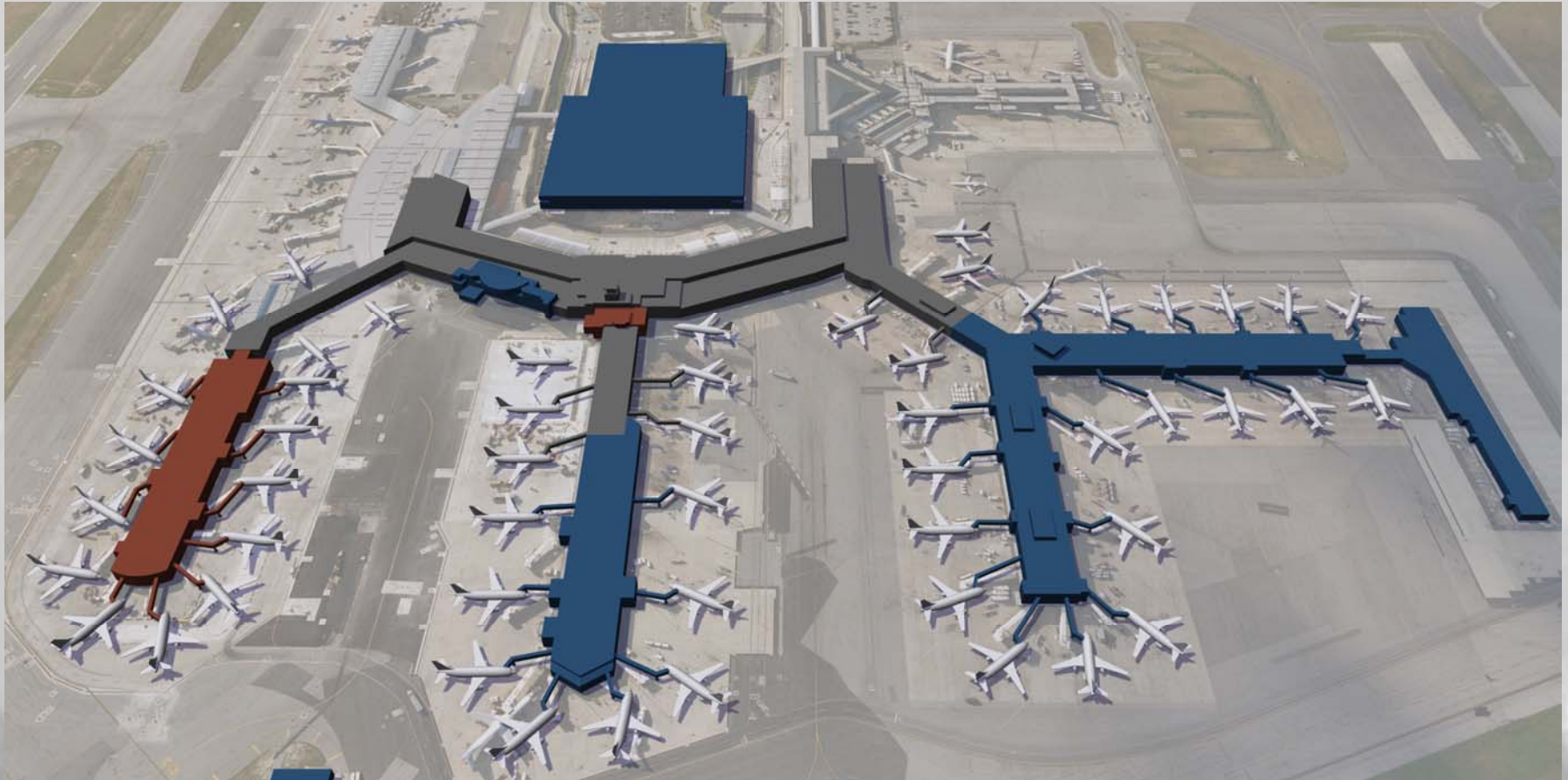
Terminal C Extension 1994

Substation C-1



Terminal B Extension/Parking Garage Addition 1998

Substations B-3, B-4, PG-1 (Expansion)



International Terminal (Pier E) 1999

Substations E-1, E-2



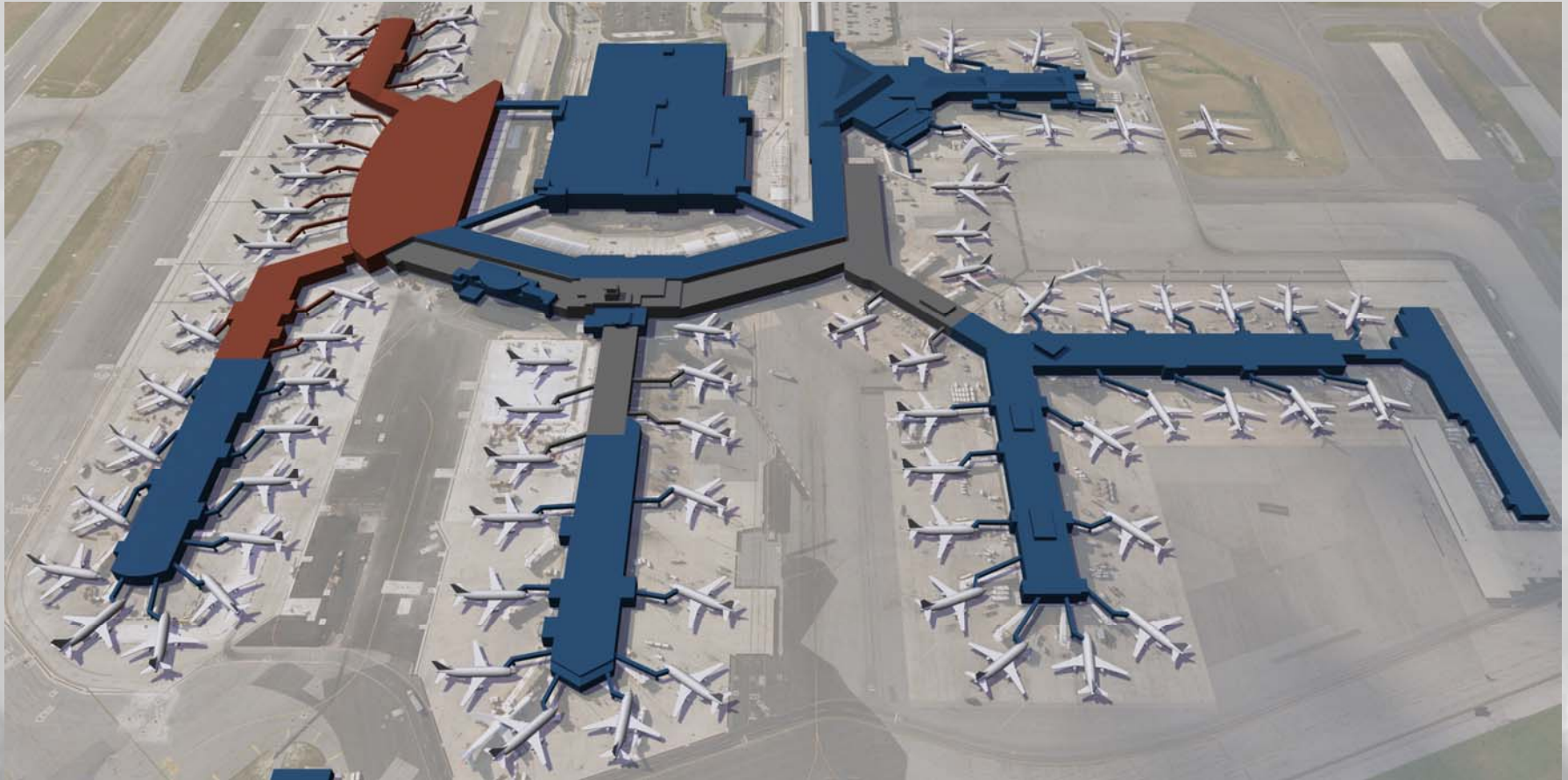
Terminal Curbside Expansion & Skywalks 2004

Substation ST-TU



Terminal A/B Expansion 2005

Substations A-1, B-1, B-2



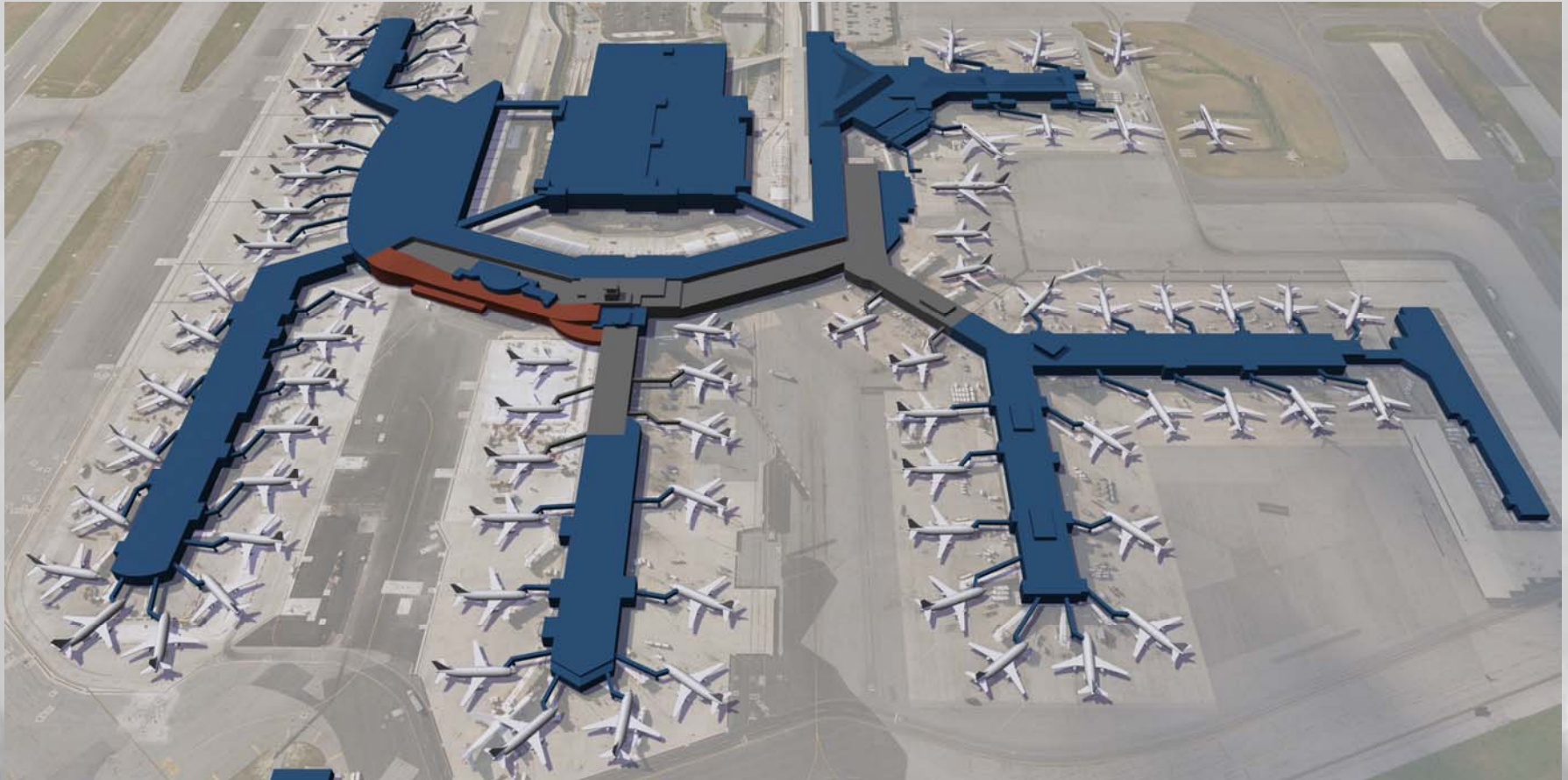
DE Baggage System Claim Improvement (DEBSCI) 2010

Major Modification to Substation E-2



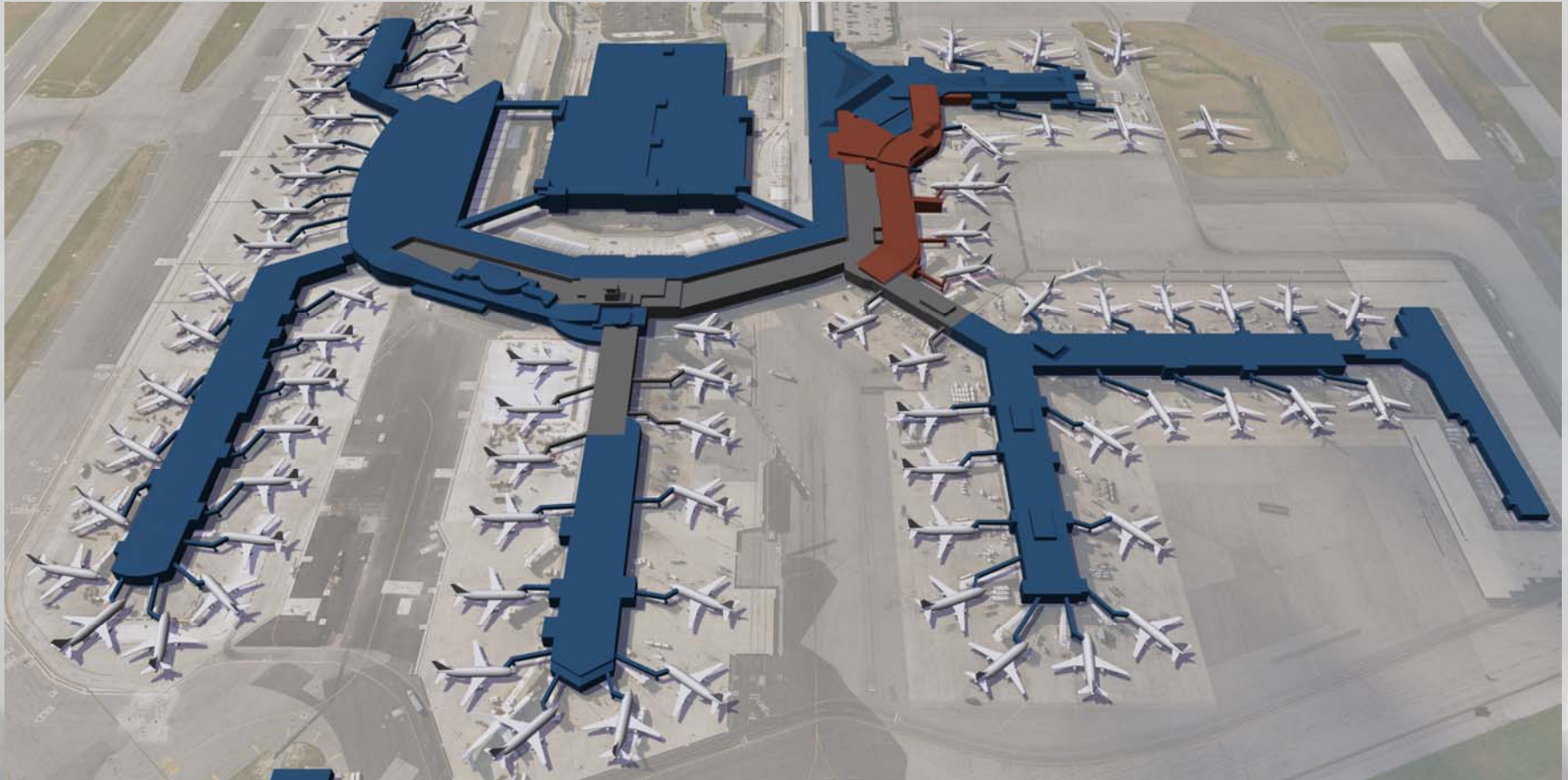
B/C Connector 2013

Substation ST-BC



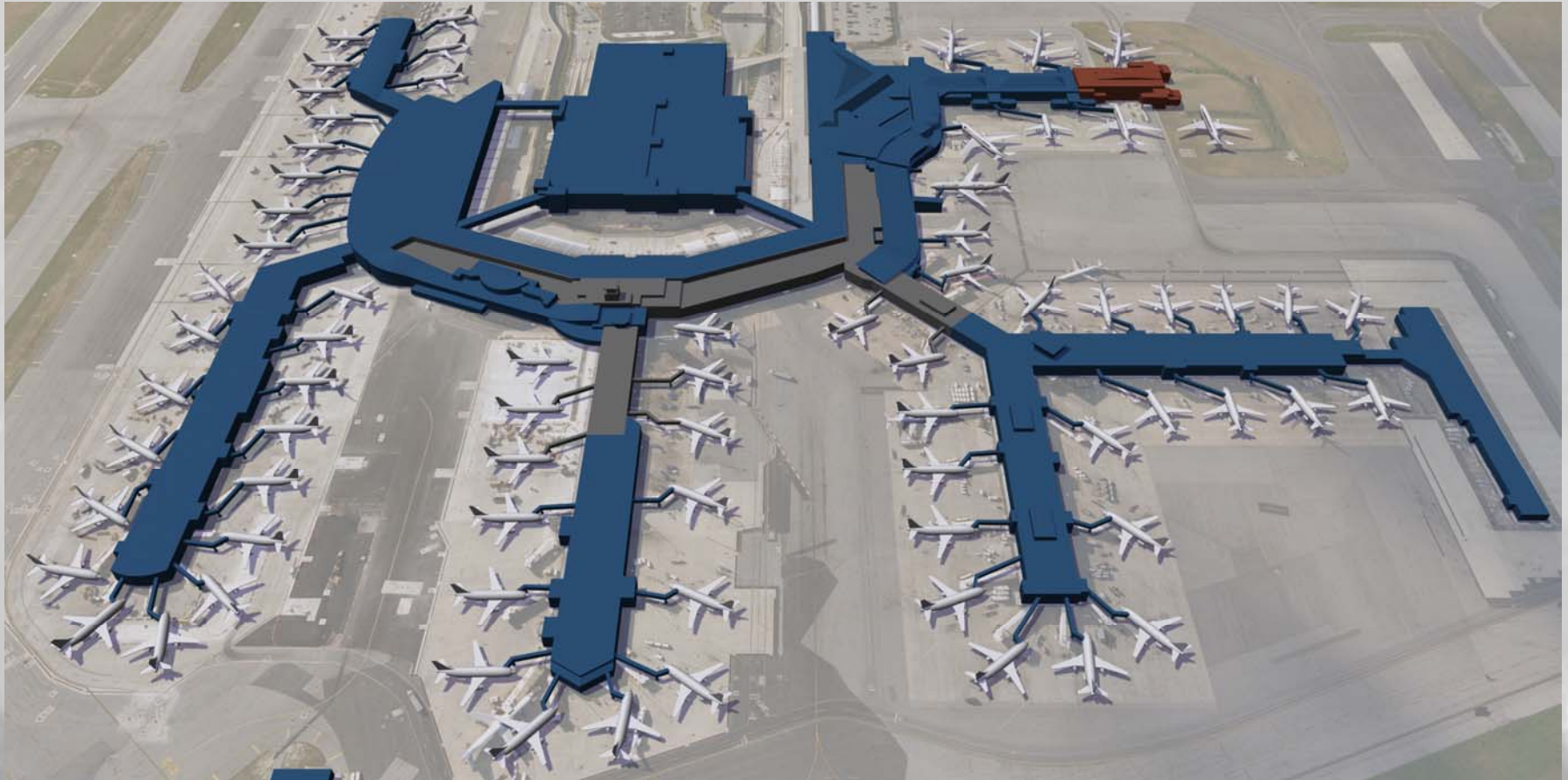
D/E Connector 2016

Substation NT-D1



Concourse E Extension 2017

Substation E-3

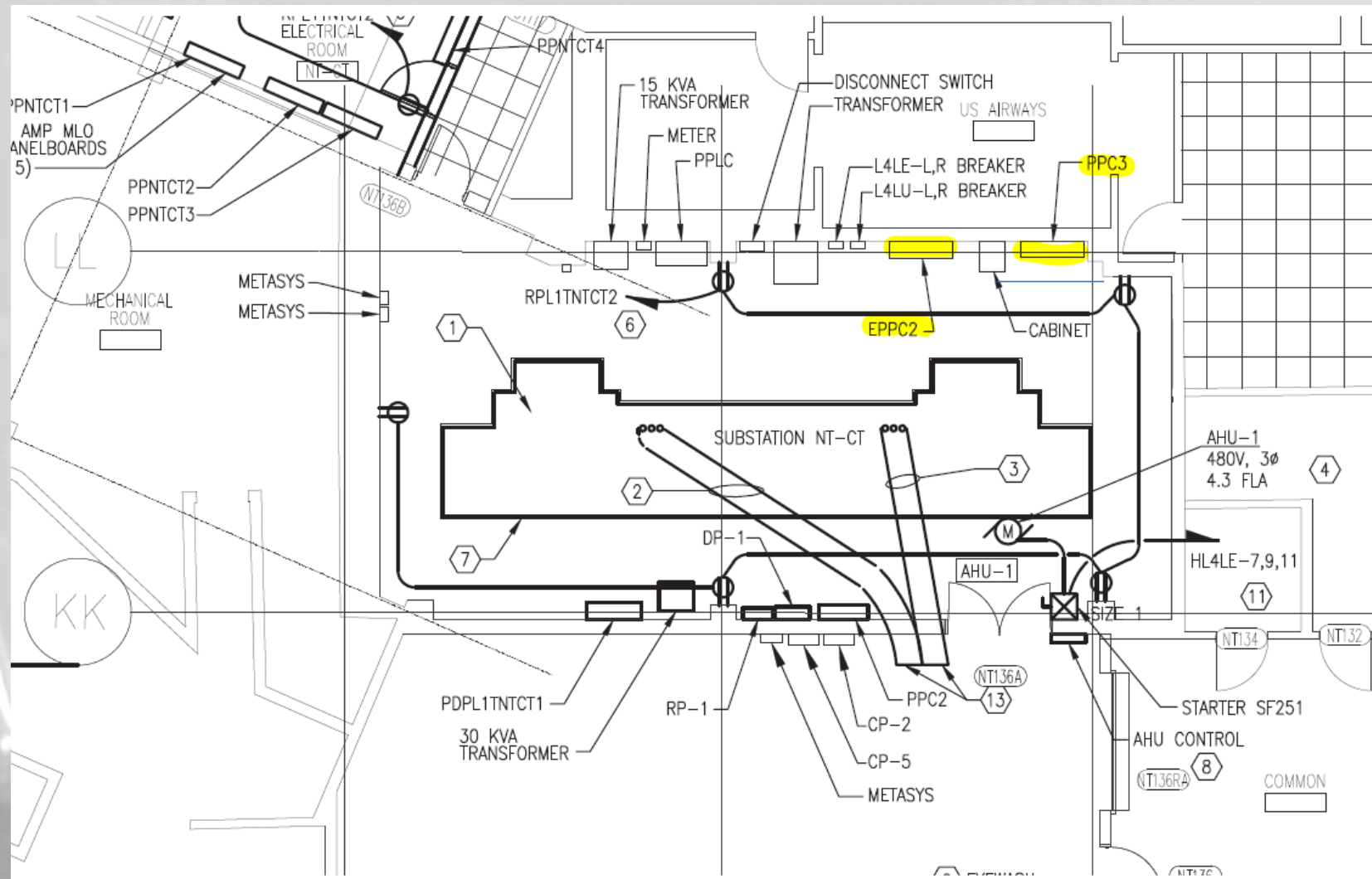


Complexity of Electrical Distribution System

The electrical system was constructed, modified, replaced through the growth of the airport over more than 60 years.

- Service area of different substations are overlapping with each other.
- Some of the electrical equipment was fed from one substation before. Now they are fed from different substation.
- Electrical equipment in the same electrical room are fed from different substations.

Complexity of Electrical Distribution System



An aerial photograph of the BWI Marshall Airport terminal and surrounding tarmac. The terminal is a large, modern building with a curved roof and multiple jet bridges extending from it. Numerous commercial aircraft are parked at the gates, and many ground support vehicles are visible on the tarmac. In the background, there are runways, taxiways, and parking lots. The word "GIS" is overlaid in large white letters in the center of the image.

GIS

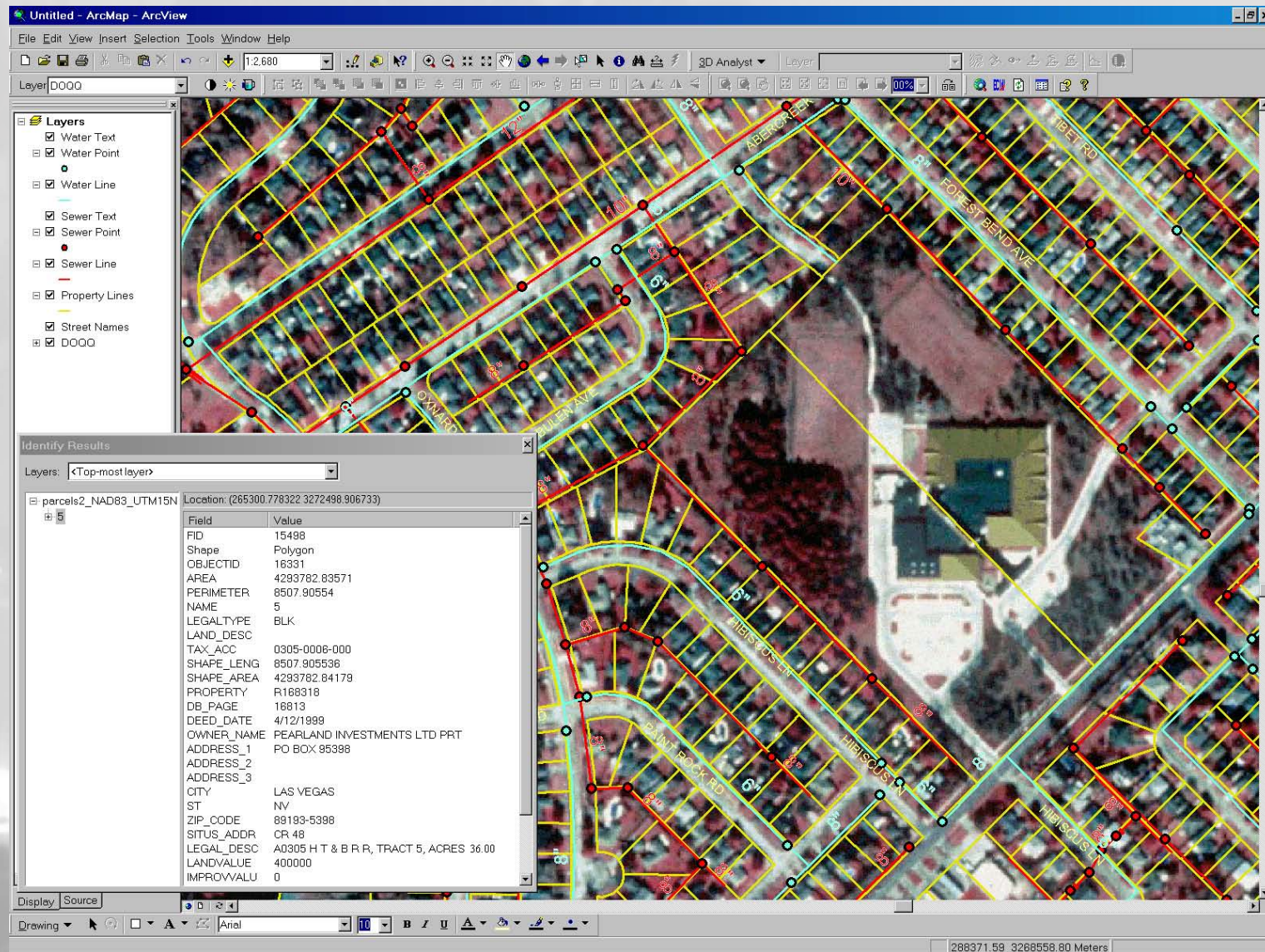
What is GIS?

GIS stands for Geographic Information System.

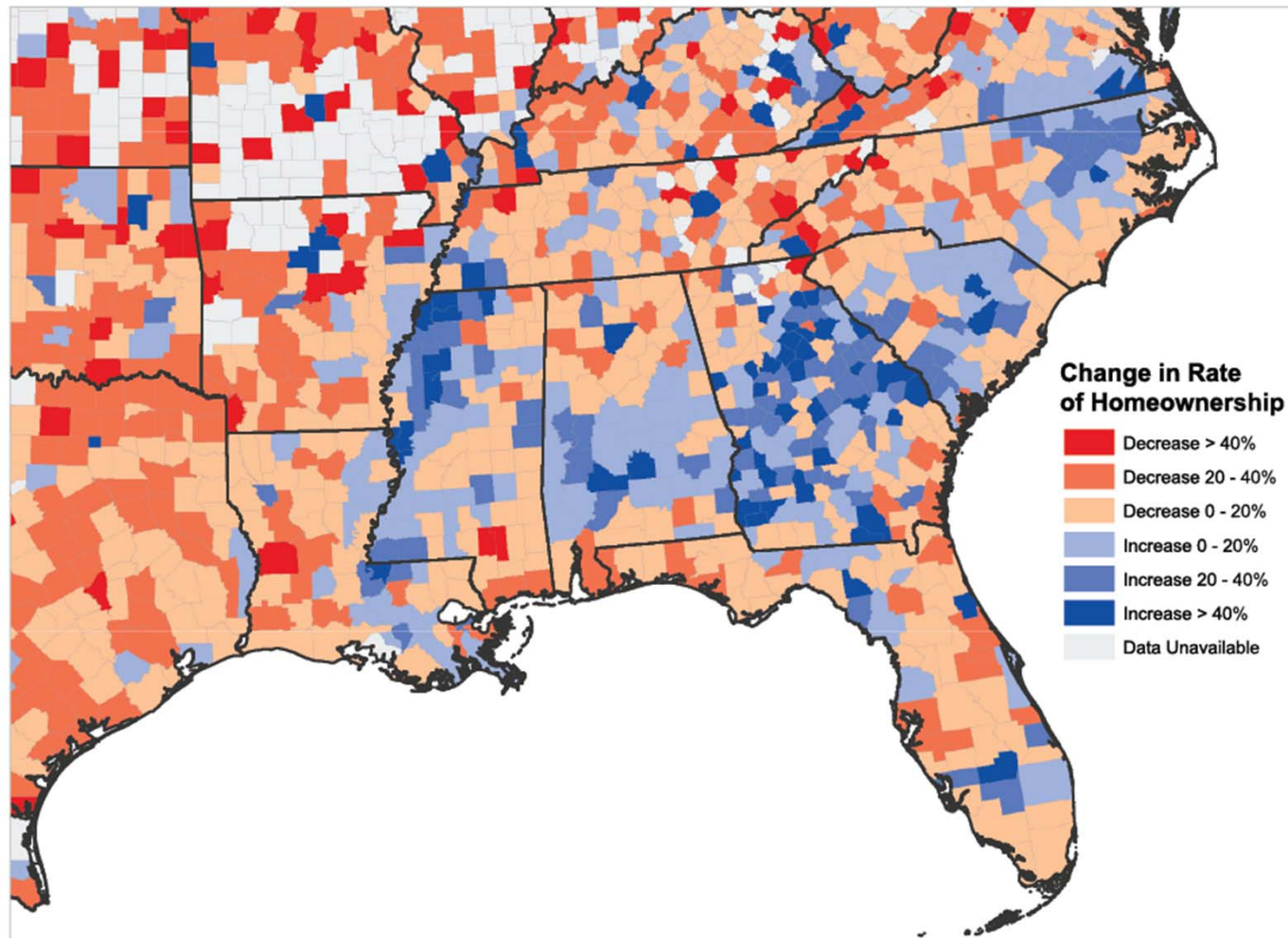
A geographic information system (GIS) is a computer system for capturing, storing, checking, analyze, and displaying data related to positions on Earth's surface. (National Geographic Society)

Geographic → Maps
Information → Data
System → Computers

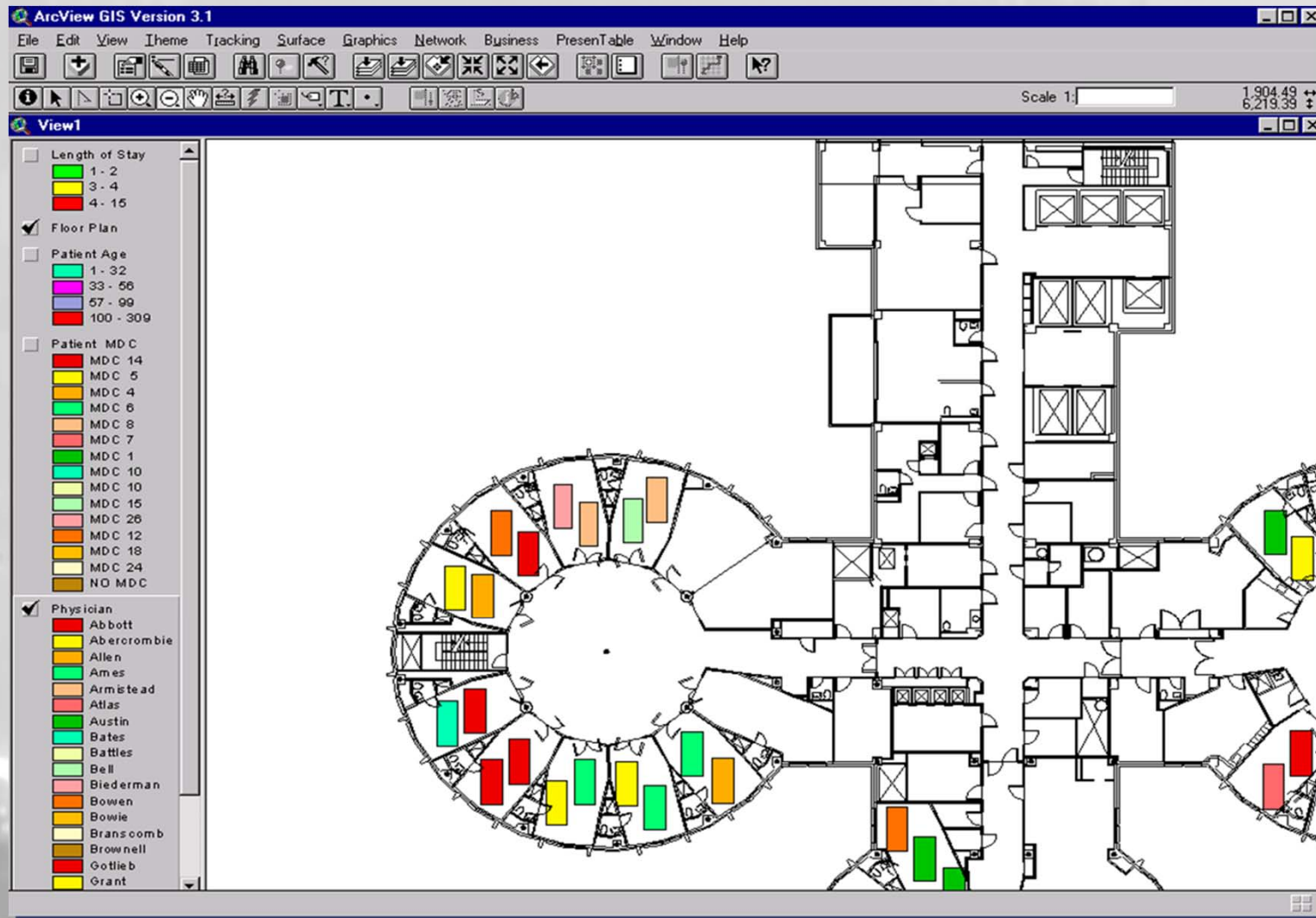
Typical GIS Application –water and sewer piping management



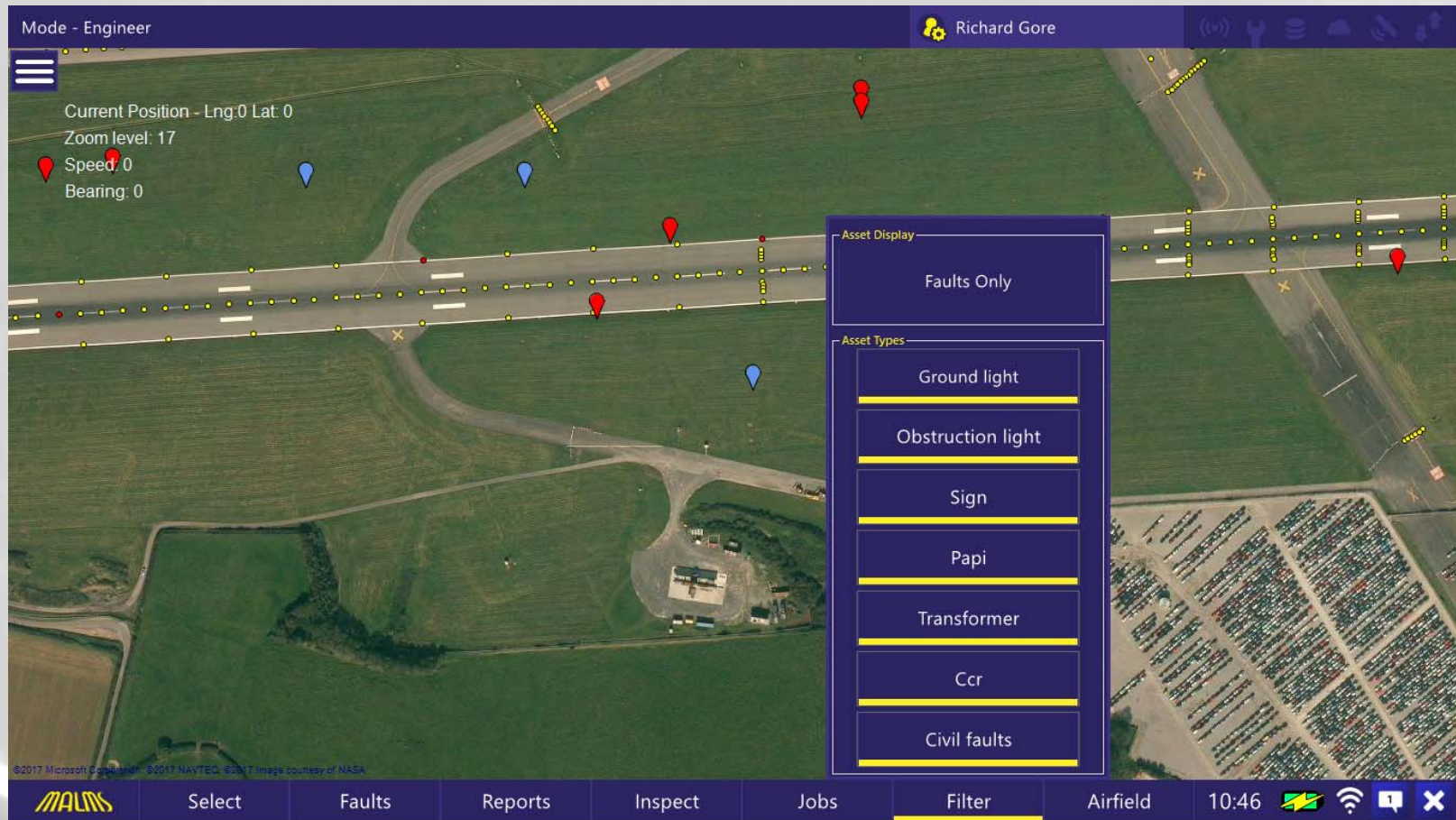
Typical GIS Application – Areas (Change in Rate of Homeownership)



Typical GIS Application – Hospital Facilities Management



Typical GIS Application – Airfield Electrical Equipment Management



Four basic categories of GIS Applications

- Environmental/natural resource management
- Urban and regional management
- Infrastructure management
- Commercial

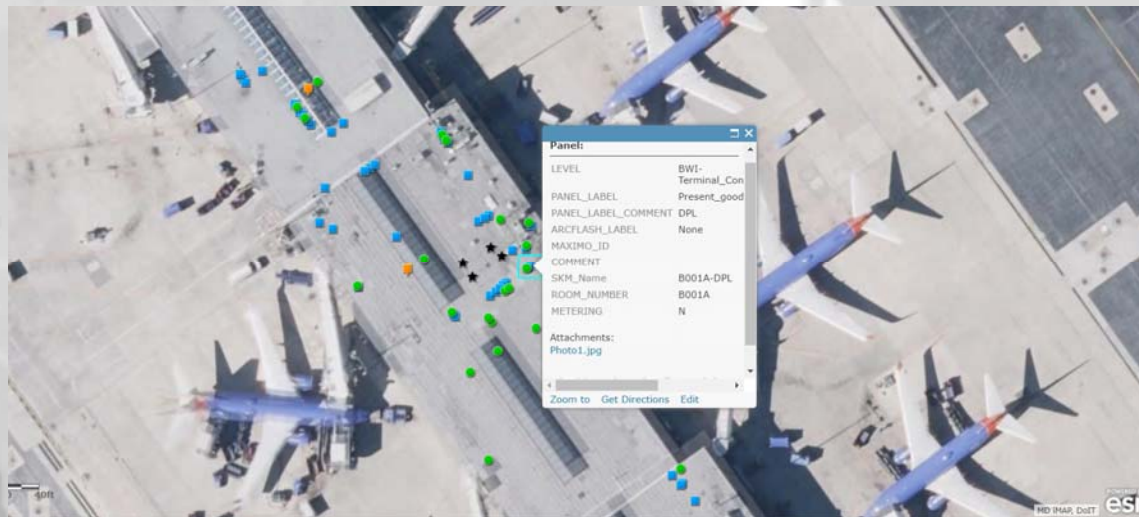
Components of GIS

- Hardware
- Software
- Data
- People
- Applications



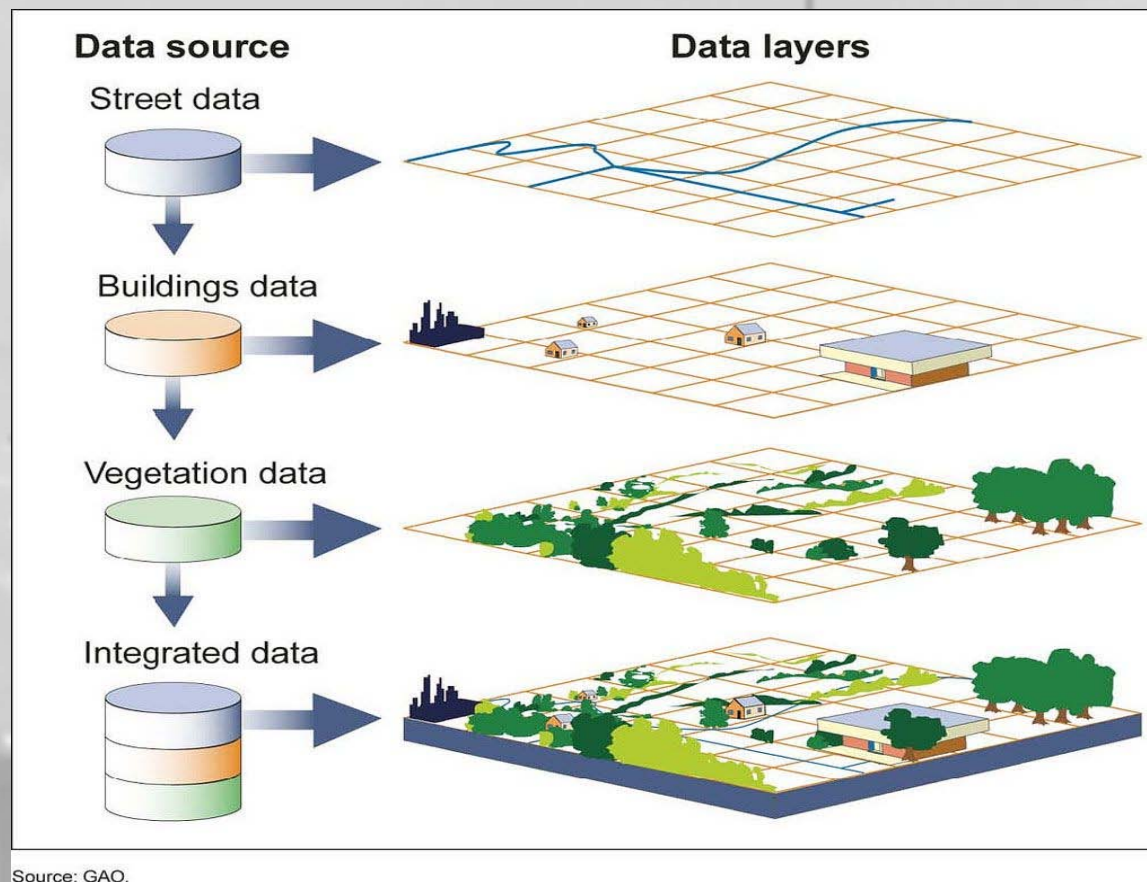
Spatial Data and Attribute Data

- Spatial data (location of an object)
 - Coordinate system
 - Latitude and Longitude
- Attribute data (information about an object)
 - Specifies characteristics at the location



GIS Architecture

Spatial data are organized into layers. GIS can show many different kinds of data on one map through different layers, such as streets, buildings, and vegetation.



Data Capture – Entering Information into the system

- Map Scan
- Remote sensing
- Field data collector

An aerial photograph of the BWI Marshall Airport. The central focus is the large, modern terminal building with a complex, multi-winged roof. Surrounding the terminal are extensive parking lots filled with cars and several large cargo and passenger aircraft parked at gates. The tarmac area is visible with various ground service equipment and smaller planes. In the background, there are green fields and some industrial or construction areas.

GIS Application for Our Study

GIS Software – App for iPad



Legend

Transformer



Panel



MCC



Switchboard



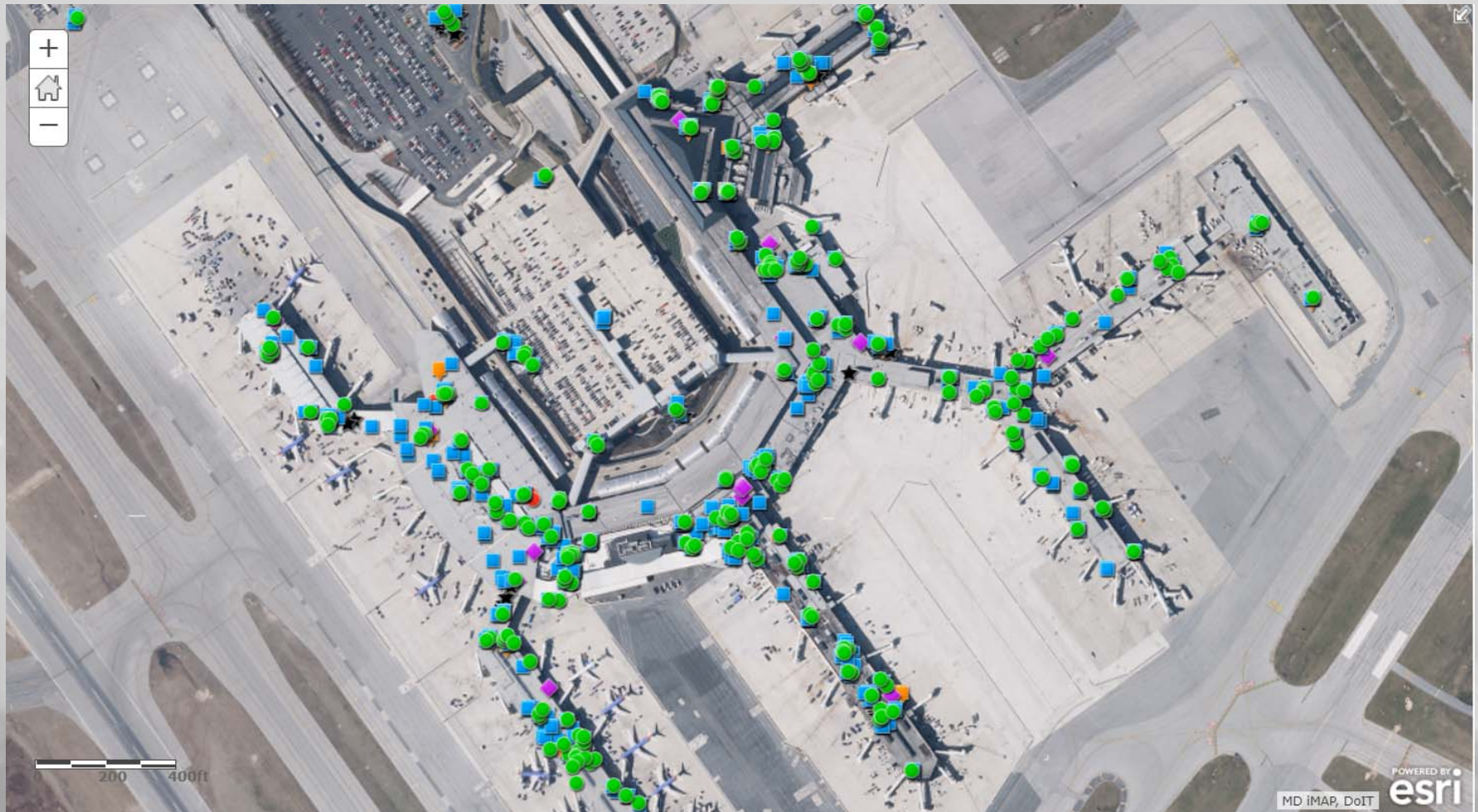
Switchgear



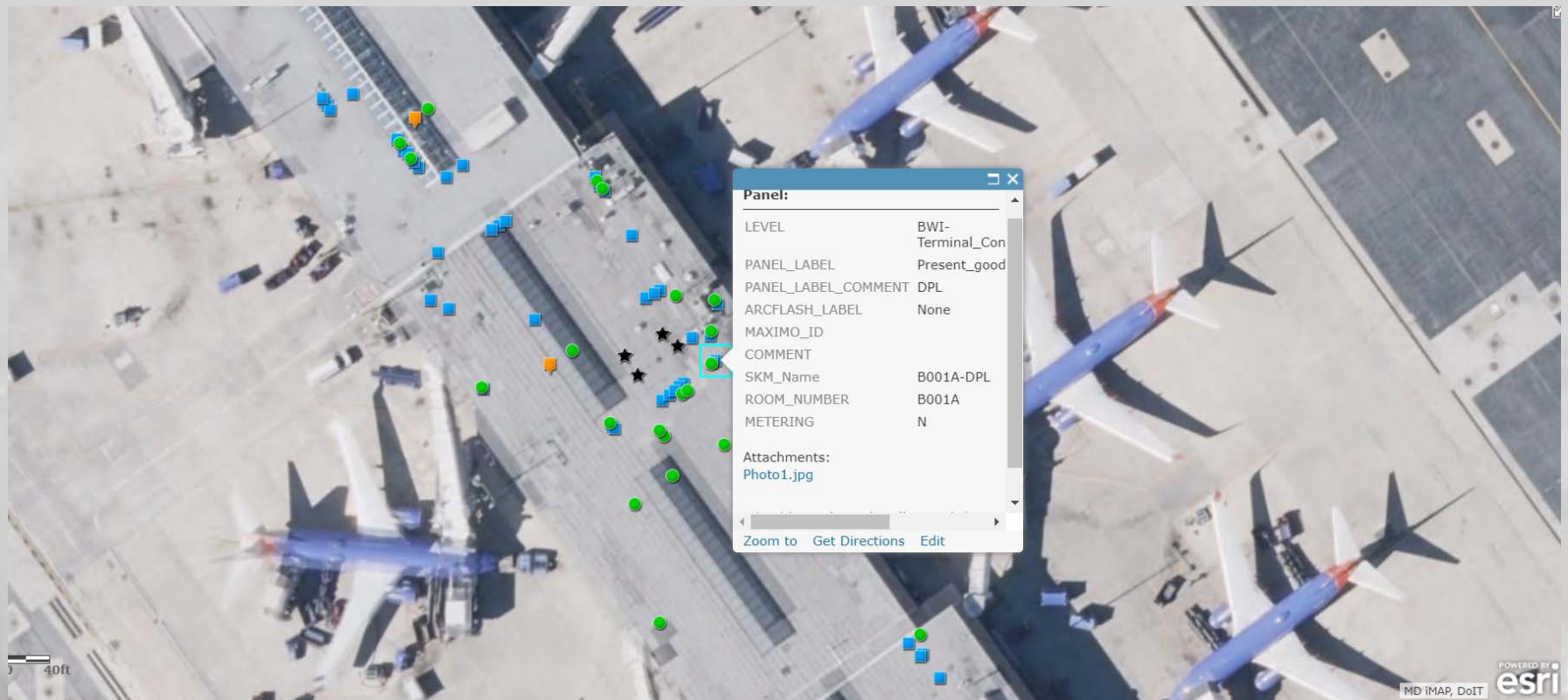
Floorplan Discrepancy



BWI GIS Map for Arc Flash Study on Desktop



Electrical Equipment Attribute Data



Electrical Equipment Attribute Data

MAA Task 4428 Data Collection

maryland.maps.arcgis.com/home/webmap/viewer.html?webmap=7f11c59eff3348639bdf262bfe06c9a5

Home ▾ MAA Task 4428 Data Collection New Map ▾ David ▾

Details Add ▾ Edit Basemap Save ▾ Share Print ▾ Directions Measure Bookmarks Find address or place

About Content Legend

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- ☒ Transformer
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- ☒ MCC
- ☒ Switchboard
- ☒ Switchgear
- ☒ Floorplan Discrepancy
- ☐ BLDG 001 003 Hangar Lower Level Anno
- ☐ BLDG 001 003 Hangar Upper Level Anno
- ☐ BLDG 004 006 Hangar Lower Level Anno
- ☐ BLDG 009 Maintenance Shop Lower Level Anno
- ☐ BLDG 009 Maintenance Shop Upper Level Anno
- ☐ BLDG 015 Administration Terminal ATCT 1st Floor Anno
- ☐ BLDG 015 Administration Terminal ATCT 2nd Floor Anno

Panel (Features: 1259, Selected: 1)

LEVEL	PANEL_LABEL	PANEL_LABEL_CODE	ARCFLASH_LABEL	MAXIMO_ID	COMMENT	SKM_Name	ROOM_NUMBER	METERING	Photos & Videos
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A18	None			A101C-RPL2A18	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LPL2A17	None			A101C-LPL2A17	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A17	None			A101C-RPL2A17	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LPL2A13	None			A101C-LPL2A13	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LSRL2A16	None			A101C-LSRL2A16	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A15	None			A101C-RPL2A15	A101C	N	(1) S

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Substation ST-TU



Panel Attribute Data Table

MAA Task 4428 Data Collection

maryland.maps.arcgis.com/home/webmap/viewer.html?webmap=7f11c59eff3348639bdf262bfe06c9a5

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Details Add ▾ Edit Basemap Save ▾ Share Print ▾ Directions Measure Bookmarks Find address or place

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- ☐ BLDG 015 Administration Terminal ATCT 2nd Floor Anno

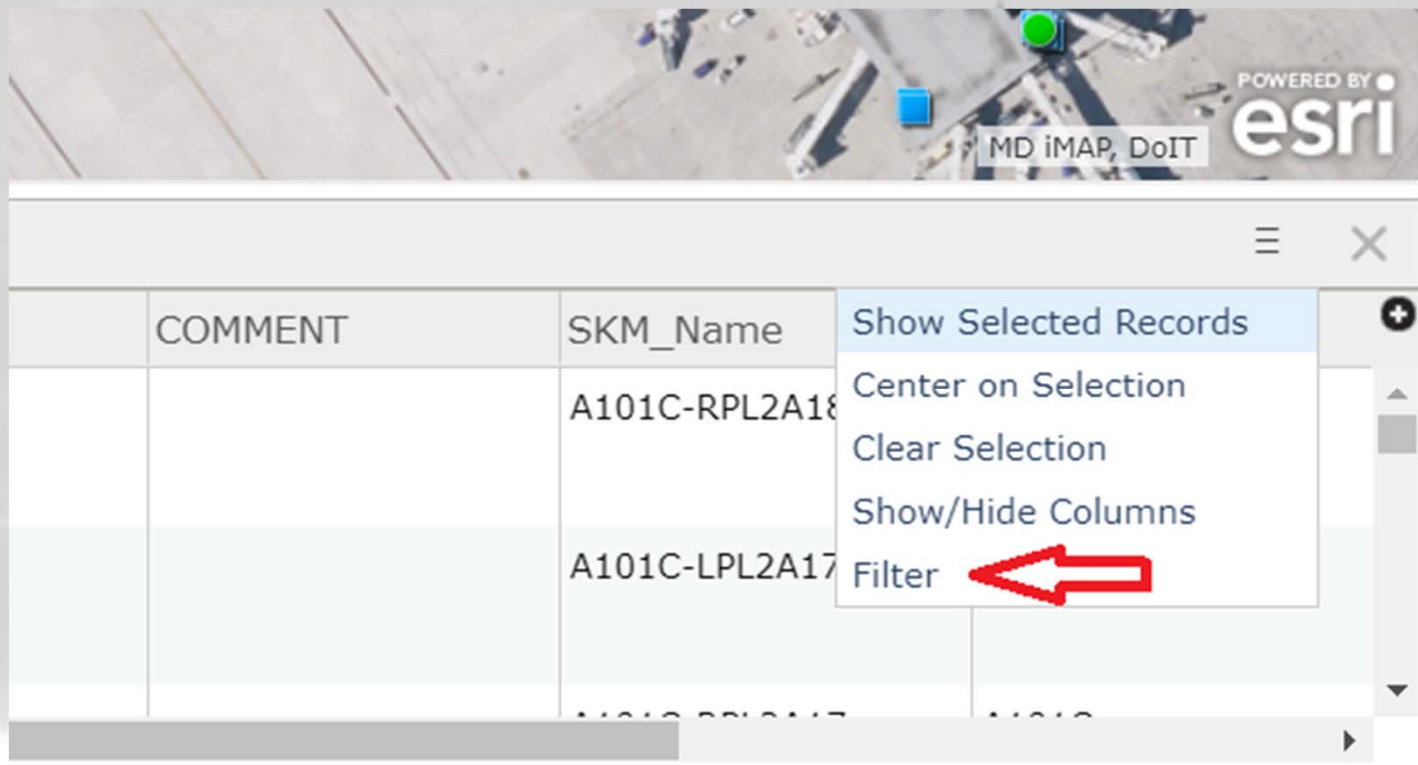
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ROOM_NUMBER NTE270
METERING N
Attachments:
Zoom to Get Directions Edit

Panel (Features: 1259, Selected: 1)

LEVEL	PANEL_LABEL	PANEL_LABEL_CC	ARCFLASH_LABEL	MAXIMO_ID	COMMENT	SKM_Name	ROOM_NUMBER	METERING	Photos
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A18	None			A101C-RPL2A18	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LPL2A17	None			A101C-LPL2A17	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A17	None			A101C-RPL2A17	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LPL2A13	None			A101C-LPL2A13	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	LSRL2A16	None			A101C-LSRL2A16	A101C	N	(1) S
BWI-Terminal_Concours e_AB_Ground_Level_1a	Present_good	RPL2A15	None			A101C-RPL2A15	A101C	N	(1) S

Panel Attribute Data Table



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	COMMENT	SKM_Name
		A101C-RPL2A18
		A101C-LPL2A17
		A101C-RPL2A17
		A101C-RPL2A17

- Show Selected Records
- Center on Selection
- Clear Selection
- Show/Hide Columns
- Filter

Panel Attribute Data Table

Filter: Panel

Create

+ Add another expression ☐ Add a set

Display features in the layer that match the following expression

PANEL_LABEL_COMM is PPC3

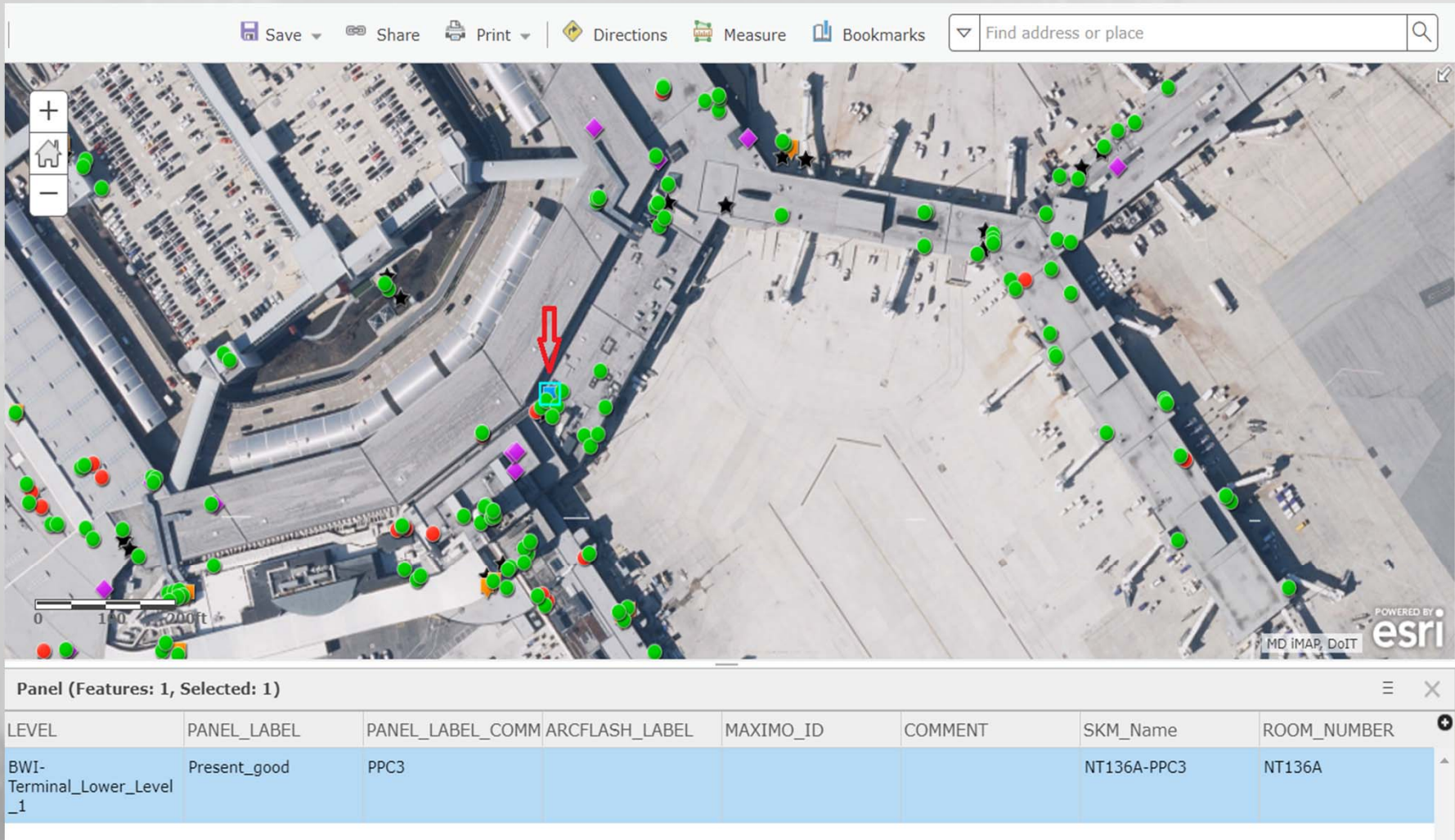
☐ Value ☐ Field ☐ Unique

☐ Ask for values

APPLY FILTER APPLY FILTER AND ZOOM TO CLOSE

Panel (Fe				
LEVEL				
BWI-Terminal_Concourse_A				
B_Ground_Level_1a				
BWI-	Present_good	LPL2A17	None	

Panel Attribute Data Table



Panel (Features: 1, Selected: 1)

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BWI Enterprise GIS Application



