Flight Line Modernization:

Leveraging Telescopic Shelters to Improve Operational Efficiency

Prepared By:
Aaron Nuut

May 12, 2010

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Leveraging Telescopic Shelters to Improve Operational Efficiency

Project lead:
Aaron Nuut

Members:
TJ Bunnell
Richard Clarke
Jason St. Marie

Submitted for partial fulfillment of requirements for IT 495 senior projects class

Engineering Technology Department

Tarleton State University

5/12/10

Project Acceptance Page

Flight Line Modernization:

Leveraging Telescopic Shelters to Improve Operational Efficiency

Project Members:
TJ Bunnell
Richard Clark
Jason St. Marie
Aaron Nuut

The following affirm that the project deliverables meets the needs of our customer and was accomplished by the project team:

Industrial Sponsor:

Name and Title Date

Faculty Mentor:

Name and Title Date

Department Approval:

Name and Title Date

Project Leader:

Name and Title Date

Table of Contents

Business Need

Current State

One component of L3 Communications Mission Integration Division is the refurbishment of aircraft. During the rebuild cycle of an aircraft, there is a period in which fuel must be loaded onboard in conjunction with additional operations and testing. Under FAA requirements, a fueled plane must either be outside or in a hangar where equipment is specified fire protection and ventilation systems. To free up space in their main hanger, and meet FAA requirements, L3 Communications places these aircraft at outside workstations. As time has passed, operations have expanded. The workstations and adjacent facilities have grown in capacity. This growth process has been an organic one. New challenges were met and problems solved individually. Consequently, this growth has naturally become a collection of "point problem" solutions, while the operations and facilities are effective at producing quality work they are not at peak efficiency. As an example, when personnel needs prints for a particular part they can retrieve them from a central Reference Documents location. This location, however, lacks the computers necessary to order those parts or print them out on a single appropriately sized sheet. With the installation of new telescopic structures over their work stations, L3 Communications is looking to carry out an overview of their current state operations to look for areas of possible improvement.

Project Scope and Goals

The Senior Design Team was tasked with collecting data on the current state operations and making recommendations for future state improvement in operational efficiency. As part of this evaluation, it was requested that recommendations be made for choosing lighting and bird deterrents for the new telescopic structures.

- Reduce travel/transport distances in stations 14 and 16
- Recommend changes to improve safety, touch labor efficiency, and reduce maintenance costs

- Develop lighting solution that meets standards for adequate lighting within the restrictions of the telescopic structures
- Develop bird deterrent solution/program within the restrictions of the structure

Project Strategy

Recommendations

Several key concerns were identified by L3 Communications including bird deterrence, lighting within the telescopic structures, and refurbishment/replacement of aging equipment. Recommendations took these concerns into account, but also focused on some additional goals. The team first looked for improvements or changes that could be made to reduce travel/transport labor requirements in accordance with the company's goal of improving travel/transport efficiency. When finding ways to reduce travel/transport labor efficiency two questions were kept in mind. First, how can travel distances for personnel be shortened or pathway intensities reduced. Second, how can equipment be rearranged, with facilities, to improve transport flow. Additionally, the team looked at ways to improve safety and touch labor efficiency as well as reduce maintenance costs. Safety issues were given top priority in terms of capital/expenses. Recommendations were developed through evaluation of the current state layouts and procedural data. Data regarding the number of personnel traveling a path in a given day, the number of times the path was traveled, and the number of days that pathway was used during the operations and testing period were multiplied together to create a pathway use intensity value. A future state layout was created that reflected the changes to movement affected by the structures. Current state intensity data was reviewed while looking for those intensity values that would not change in the future state. Areas in the future state that had potential for increased efficiency were evaluated and new intensity values developed to reflect these recommendations. Once a full evaluation was made of the current and future states, a future state spreadsheet was developed with new intensity and

distance values for each pathway allowing a comparison to be made in distance traveled and time consumed in current and future states.

Deliverables

L3 Communications, Mission Integration Division will receive the following:

- Current state station layouts (CAD) of ground and flight testing operations
- Proposed station layouts (CAD) to support ground and flight testing operations
- Prioritized list of capital/expense items: equipment and tools needed to implement the proposed plan
- Summary (PowerPoint presentation) of future state plans to maximize productivity

Project Cost

Purchase Computer Stations:	$ 12,000
Purchase Radios:	$ 600
Purchase All-Weather Equipment Carts:	$ 7,200
Near Term Building 143 Modifications:	$ 7,200
Station 15 Equipment Storage:	$ 10,500
Total Cost:	$ 37,500

Projected Savings

Current State Annual Labor Hours Consumed:	3,607 hrs
Future State Annual Labor Hours Consumed:	2,255 hrs
Reduction in Annual Labor Hours Consumed:	1,352 hrs

Labor Rate: $100/hr

Labor Cost Savings: $135,000

Payback Period: 3-4 months

Facsimile for Initial Agreement of Deliverables

Tarleton Flight Line Project Notes

Equipment Recommendations:

- Purchase portable lights to support night ops
- Provide mobile computing capabilities to minimize travel to/from 144 for Ref Docs
- Replace ladder truck
    - Multiple wear points – frequently down for repair
    - Mileage unknown – cannot be determined via odometer
    - Cannot determine when vehicle is in park – transmission shifter faulty
- Replace 50 ton pneumatic-powered jack
    - Pneumatic power capability no longer functional – force required to operate in manual mode may lead to injury
- Refurb/replace Hydraulic Power Cart
    - Hoses/seals leak on ground creating a safety hazard
    - Continually down for service
    - Single point of failure
- Refurb/replace forklift
    - Approaching end of useful life
    - Used 15+ times per day (3+ hours of duration)
    - Single point of failure
- Replace A/C Hose Trailer
    - Hard casters incompatible with service conditions (rough road leading to Pea Patch)
    - Plywood doors are a safety hazard in windy conditions – open on vertical axis
    - Evidence of multiple door failures (hinge and/or attach point failures)
    - Door broke free from trailer en route to Pea Patch during our visit
    - Existing trailer fabricated in house at minimal expense – less than 1 year old
    - New unit required with large pneumatic wheels and horizontal axis doors (roll-up or lift w/ strut supports), and metal structure/dividers (no plywood)
- Refurb panel containers
    - Replace rotting or damaged wood/plastic components
    - Refinish to protect from the elements
- Refurb oxygen cart
- Refurb nitrogen cart
- Refurb pickling cart
- Refurb electrical box/cord used for remote power; fabricate a second unit
- Outfit tool/equipment trailer for Pea Patch to minimize travel/transport requirements (recently purchased trailer – purchase tools/materials to complete)
- Purchase/fabricate a shelter for support equipment (jacks, nitrogen cart, lubricants, etc) to eliminate premature wear and tear from exposure to the elements

- Purchase/fabricate shelters for station tool boxes
- Purchase carts with pneumatic tires for transporting equipment to/from the stations – material flow paths being extended due to shelter rails/drives
- Replace faulty air conditioning hoses
- Replace faulty jet starter hoses

Building Recommendations:

Near Term:

- Swap position of Tool Crib and Conference Room to minimize travel between Tool Crib, CAPPS Crib, and stations

Next Steps:

- Perform a comprehensive engineering study on the space requirements for 143 and optimize the layout to leverage expanded operational capabilities with telescoping shelters
    - Eliminate use of 144 trailers – relocate all personnel to 143
    - Co-locate FL customer, L-3 Pgm Office, FLT Mgt, and FLP Mgt
    - Relocate Reference Docs from 144 trailers to 143, minimizing travel to stations
    - Co-locate FLP, FLT, and support personnel, minimizing travel/transport
    - Re-allocate space to optimize lab/test areas
    - Re-locate raw stock area to minimize travel/transport to stations
- Evaluate options for adding a shelter in ST13 to support aircraft download, drop-in work, and overflow from ST14/16

Deliverables:

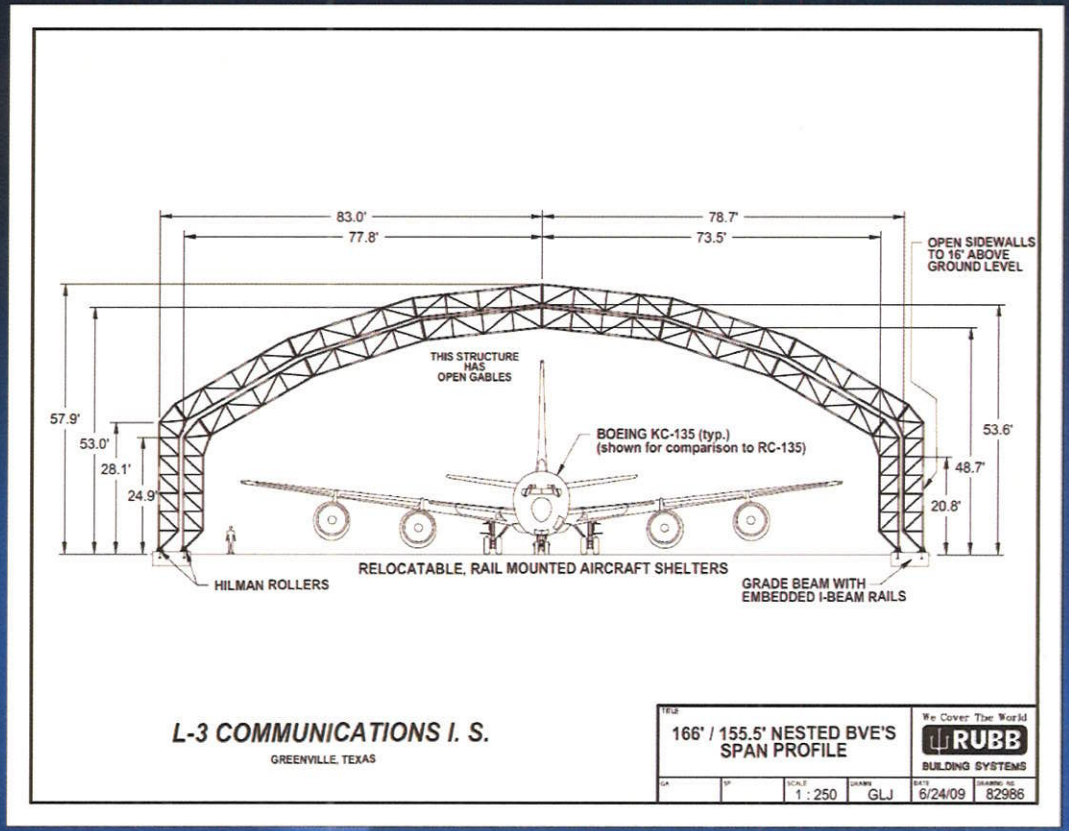
- CAD drawing of existing travel/transport paths
- Existing state travel/transport analysis (Excel)
- CAD drawing of future state travel/transport paths
- Future state travel/transport analysis (Excel)
- Powerpoint presentation
    - Overview of March 11-12 workshop at L-3
    - Illustrated overview of problem solving methods
    - Overview and analysis of existing operational state
    - Recommendations for future state
        - Travel/transport routes
        - Equipment with estimated costs/benefits (prioritized)
        - Facility modification/building plans with estimated benefits
        - Preventive maintenance plan for shelters/drives and equipment

TARLETON STATE UNIVERSITY

L-3 Senior Capstone Project
Department of Engineering Technology

Spring 2010

T.J. Bunnell
Richard Clarke
Jason St. Marie
Aaron Nuut



Flight Line Modernization

Leveraging Telescoping Shelters to Improve Operational Efficiency

Mission Integration Division Operational Overview


Multi-Sensor Test Facility


Mod and Sim Lab

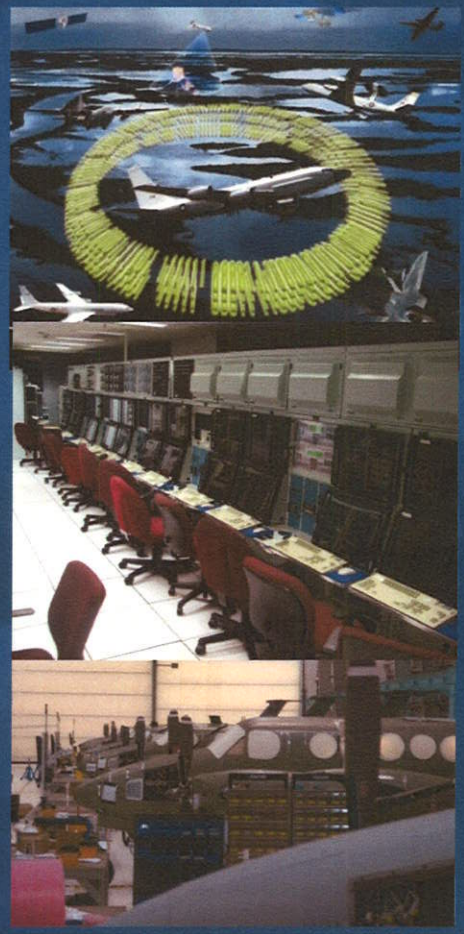

Data Management System Lab


Anechoic Chamber

- 1M+ sq-ft ops floor space; 10K ft runway
- 49K+ sq-ft SCIF space
- System Development & Integration Labs
- MSTF replicates electronic environment including threat reproduction / simulation
- CMMI-DEV Maturity Level 5, v1.2
- ISO9001:2008 and AS9100 Rev B certified

Core Capabilities at MID

- Airborne C4 and ISR Systems
- Signals Sensors and Processing
- Network-Enabling Technologies
- Systems Design, Development, Integration & Test
- Quick-Reaction System Capabilities
- Full Life Cycle System Support and Sustainment
- Aero Analysis and Certification (FAA, etc.)
- Special Mission Aircraft Modification, Integration, and Engineering



ARMING THE WARFIGHTER WITH ADVANCED TECHNOLOGY... ENSURING IT'S NOT A FAIR FIGHT

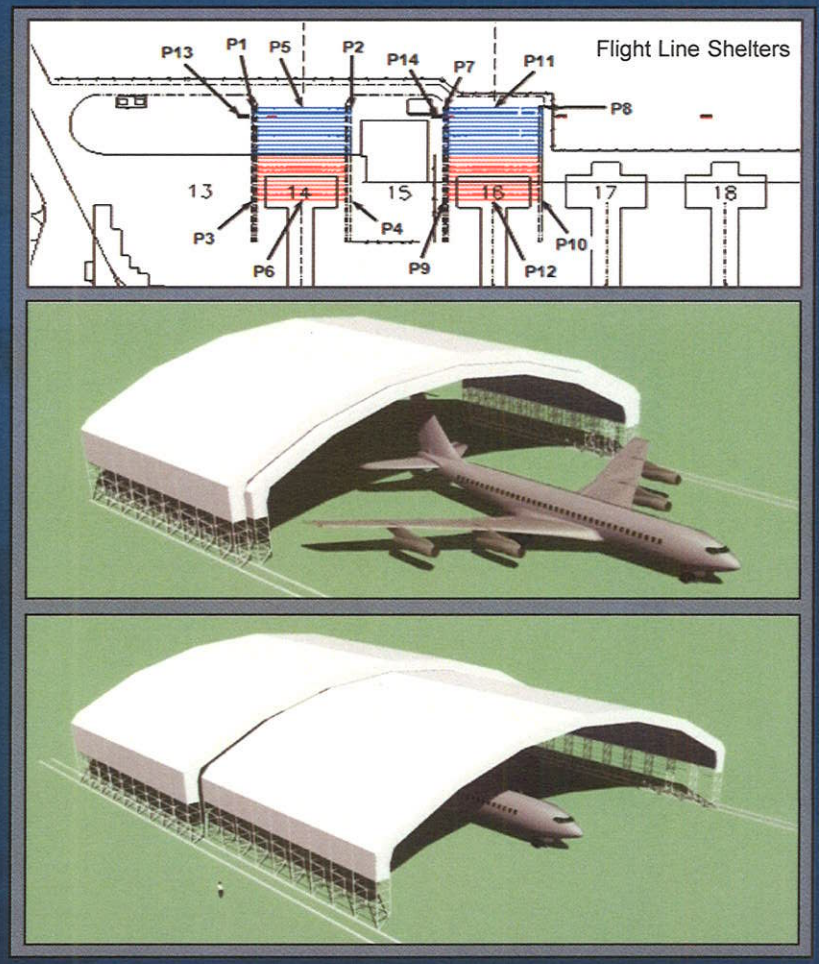
Project Overview

Project Description:

- Students worked with senior industrial and manufacturing engineers to transform the L-3 Flight Line Shelter CONOP (concept of operation) into an executable production plan.
- A workshop was conducted on site to facilitate the study of requirements and workflows, enabling students to develop proposed station layouts and production methods to achieve future state performance objectives.

Deliverables:

- Proposed station layouts (CAD) to support ground and flight testing operations
- Prioritized list of capital/expense items: equipment and tools needed to implement the proposed plan
- Summary (PowerPoint presentation) of future state plans to maximize productivity



Motorized, tensioned-membrane shelters ready to support aircraft ground and flight testing operations in June 2010

Planning & Execution

Team Members:

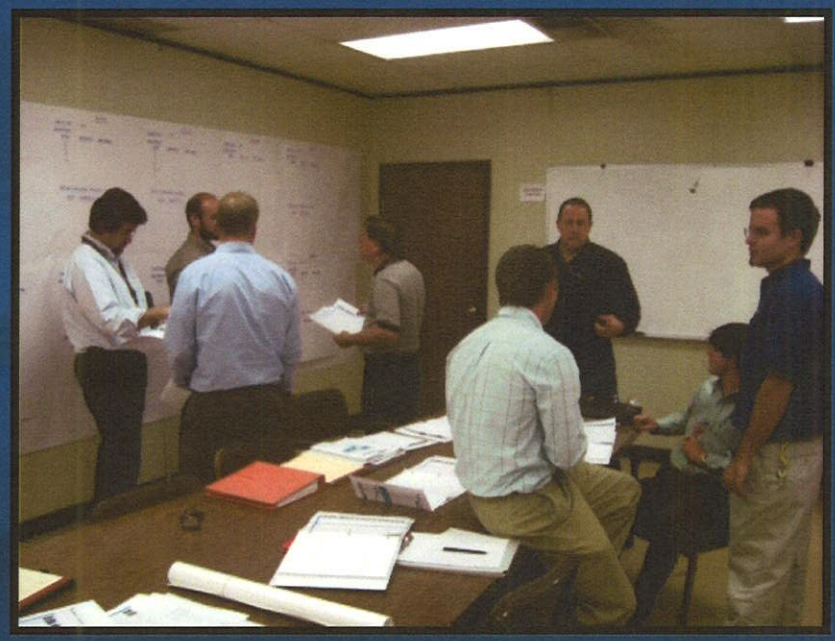
- T.J. Bunnell – AutoCad Drafter
- Richard Clarke – Manufacturing Management
- Jason St. Marie – Research & Presentation
- Aaron Nuut – Team Leader

Goal: To provide solutions for creating a streamlined work environment after the installation of telescoping shelters.

All Information gathered for this project was collected during a comprehensive work flow study at L3 Communications Mission Integration Division with the support of shift managers and supervisors.

Data Collection

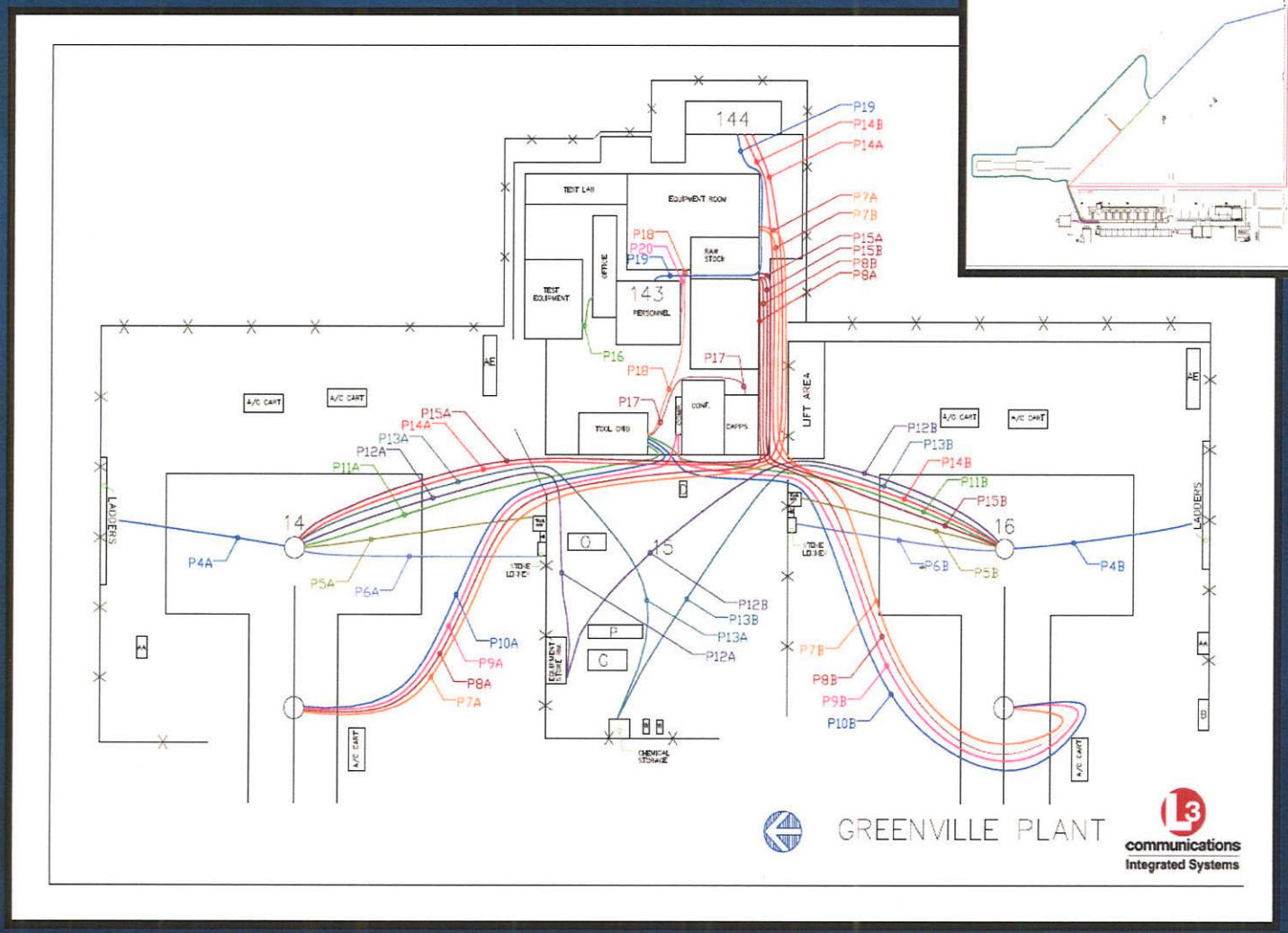
Workshop on March 11-12



Students and L3 Staff:

- Established personnel and vehicle pathways
- Determined pathway utilization during each task
- Calculated pathway usage intensity for each task
- Calculated path lengths
- Developed relevant facility floor plan
- Collected light intensity data throughout facility
- Examined existing equipment and facilities for potential problems
- Follow-up session held on campus March 26 to close information gaps from site study

Current State Travel/Transport Paths



Current State Travel/Transport Summary

Path	Path Type	Distance (feet)	Path Description	FLT Intensity	FLP Intensity	Total Intensity	Total Distance (1,000 ft)	Labor Hours
P1	Vehicle	14,784	Flight Line Blg 143 to Pea Patch	256	144	400	5,914	74.7
P2	Vehicle	11,616	Flight Line Blg 143 to Trim Pad	0	10	10	116	1.5
P3	Personnel	737	Flight Line Blg 143 to Paint Hangar	0	68	68	50	3.8
P4	Personnel	88	Aircraft Exterior to Ladders	0	912	912	80	6.1
P5	Personnel	111	Aircraft Exterior to Tool Box	0	4,560	4,560	504	38.2
P6	Personnel	111	Aircraft Exterior to Store Locker	0	76	76	8	0.6
P7	Personnel	321	Aircraft Interior to Equipment Room	8,606	0	8,606	2,758	209.0
P8	Personnel	300	Aircraft Interior to Raw Stock	0	3,260	3,260	978	74.1
P9	Personnel	239	Aircraft Interior to Computers	0	5,348	5,348	1,275	96.6
P10	Personnel	241	Aircraft Interior to Tool Crib	0	3,800	3,800	914	69.2
P11	Personnel	199	Aircraft Exterior to Tool Crib	0	5,320	5,320	1,059	80.2
P12	Personnel	249	Aircraft Exterior to Equipment Storage Area	0	152	152	38	2.9
P13	Personnel	254	Aircraft Exterior to Chemical Storage	0	90	90	23	1.7
P14	Personnel	307	Aircraft Exterior to Reference Documents	0	5,922	5,922	1,815	137.5
P15	Personnel	247	Aircraft Exterior to Raw Stock	0	2,736	2,736	674	51.1
P16	Personnel	16	Office to Test Equipment	3,768	0	3,768	60	4.6
P17	Personnel	62	Tool Crib to CAPPS Crib	0	3,800	3,800	236	17.8
P18	Personnel	75	Tool Crib to Equipment Room	3,300	0	3,300	248	18.8
P19	Personnel	116	Reference Documents to Support Personnel	0	1,216	1,216	141	10.7
P20	Personnel	19	Equipment Room to Support Personnel	1,860	0	1,860	35	2.7
			Total per Aircraft:	17,790	37,414	55,204	16,927	901.7
			Annual total at AAIP Production Rate:	71,160	149,657	220,817	67,707	3,606.6

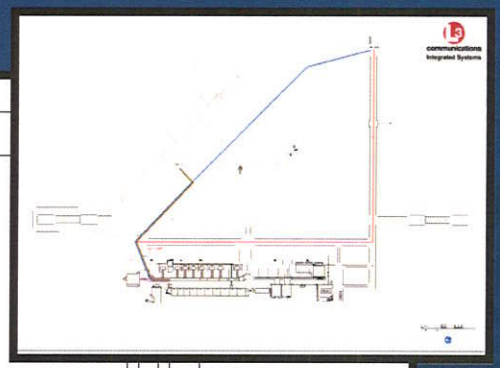
Assumptions:

Walking Speed is 2.5 miles/hr = 13,200 ft/hr (2.5 miles/hr x 5,280 ft/mile = 13,200 ft/hr)

Vehicle Speed is 15 miles/hr = 79,200 ft/hr (15 miles/hr x 5,280 ft/mile = 79,200 ft/hr)

Annual Distance Traveled: 67,707,000 feet
Annual Labor Time Consumed: 3607 hours
Annual Labor Cost: $360,700

Future State Travel/Transport Paths



Future State Travel/Transport Summary

Path	Path Type	Distance (feet)	Path Description	FLT Intensity	FLP Intensity	Total Intensity	Total Distance (1,000 ft)	Labor Hours
P1	Vehicle	8,479	Flight Line Blg 143 to Pea Patch	256	144	400	3,392	42.8
P2	Vehicle	3,632	Flight Line Blg 143 to Trim Pad	0	10	10	36	0.5
P3	Personnel	737	Flight Line Blg 143 to Paint Hangar	0	68	68	50	3.8
P4	Personnel	63	Aircraft Exterior to Ladders	0	912	912	57	4.4
P5	Personnel	199	Aircraft Exterior to Chemical Storage	0	90	90	18	1.4
P6	Personnel	172	Aircraft Exterior to Tool Crib	0	5,320	5,320	912	69.1
P7	Personnel	222	Aircraft Exterior to Equipment Storage Bay	0	152	152	34	2.6
P8	Personnel	356	Aircraft Interior to Equipment Room	8,606	0	8,606	3,059	231.8
P9	Personnel	256	Aircraft Interior to Tool Crib	0	3,800	3,800	973	73.7
P10	Personnel	266	Equipment Storage Bay to Locker Cart	0	4	4	1	0.1
P11	Personnel	388	Raw Stock to Raw Stock Cart	0	144	144	56	4.2
P12	Personnel	354	Reference Documents to Computer Cart	0	14	14	5	0.4
P13	Personnel	82	Aircraft Exterior to Locker Cart	0	76	76	6	0.5
P14	Personnel	82	Aircraft Exterior to Raw Stock Cart	0	2,736	2,736	224	17.0
P15	Personnel	82	Aircraft Exterior to Computer Cart	0	5,922	5,922	486	36.8
P16	Personnel	58	Aircraft Interior to Computer Cart	0	5,348	5,348	310	23.5
P17	Personnel	58	Aircraft Interior to Raw Stock Cart	0	3,260	3,260	189	14.3
P18	Personnel	10	Office to Test Equipment	3,768	0	3,768	38	2.9
P19	Personnel	48	Reference Documents to Support Personnel	0	1,216	1,216	58	4.4
P20	Personnel	19	Equipment Room to Support Personnel	1,860	0	1,860	35	2.7
P21	Personnel	74	Tool Crib to Equipment Room	3,300	0	3,300	244	18.5
P22	Personnel	30	Tool Crib to CAPPS	0	3,800	3,800	114	8.6
			Total per Aircraft:	17,790	33,016	50,806	10,299	563.8
			Annual total at AAIP Production Rate:	71,160	132,064	203,224	41,195	2,255.2

Assumptions:

Walking Speed is 2.5 miles/hr = 13,200 ft/hr (2.5 miles/hr x 5,280 ft/mile = 13,200 ft/hr)

Vehicle Speed is 15 miles/hr = 79,200 ft/hr (15 miles/hr x 5,280 ft/mile = 79,200 ft/hr)

Pathway Distanced Reduction : 38%

Effective Labor Cost Savings : $135,000

Recommendations to Reduce Travel/Transport Labor Requirements

1) Purchase Computer Stations with wireless network and printer
2) Purchase radios for vehicles traveling to Pea Patch and Trim Pad
3) Purchase All-Weather Equipment Carts

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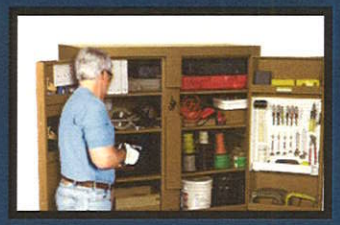


Recommendations to Reduce Travel/Transport Labor Requirements

4) Building 143

- Swap position of Tool Crib and Conference Room to minimize travel between Tool Crib, CAPPS, and Aircraft Stations
  - Recommend future comprehensive engineering analysis recommended for fully optimizing 143

5) Station 15

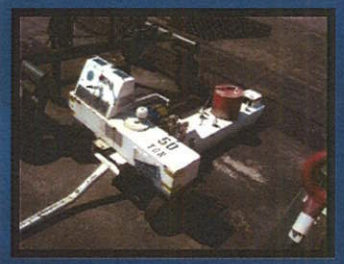
- Purchase building for the equipment storage area (Equipment Storage Bay)
- Provide storage for jacks, nitrogen cart, etc

Recommendations to Improve Safety, Touch Labor Efficiency, and Maintenance Costs

1) Replace Ladder Truck
2) Replace 50t Pneumatic Powered Jack
3) Refurbish/replace Hydraulic Power Cart
4) Refurbish/replace Forklift
5) Refurbish Oxygen Cart
6) Refurbish Nitrogen Cart
7) Stock and Organize Stock Trailer

1

2



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6

7

Recommendations to Improve Safety, Touch Labor Efficiency, and Maintenance Costs

8) Refurbish Pickling Cart

9) Refurbish existing Electrical Box/Cord
   - Build second unit

10) Replace faulty Jet Starter Hoses

11) Refurbish Panel Containers

12) Replace faulty PCA rigid hose
   - Switch to flat hose

13) Replace A/C Hose Trailer
   - Purchase reels and/or baskets for flat hose

8


9


10


11

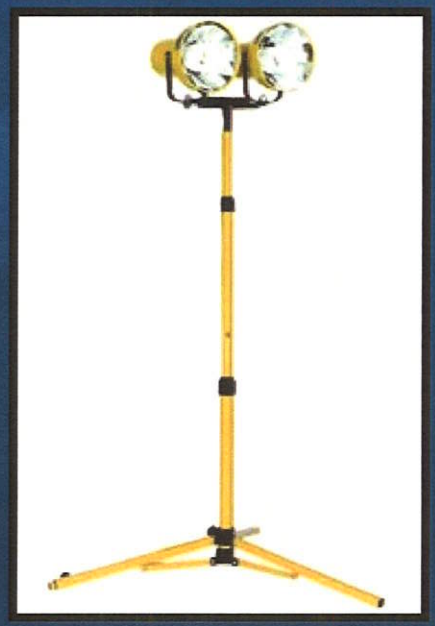

12


13


Recommendations for Lighting to Support Night Ops

Portable Fluorescent Lighting

- Provides bright lighting where required
- Reduced power consumption and heat output compared to metal halide or halogen
- OSHA recommended lighting intensity is approximately 90 ft-c



values in ft-c	Bay 304 AM	Bay 304 PM	Bay 4 AM	Bay 4 PM	Bay 3 AM	Bay 3 PM
Fuselage Exterior	178 140	17 --	41 --	-- --	15.8 8.7	26 --
Wing Inboard	7.5 --	2.2 --	10 17	3 --	14.5 --	1.4 --
Wing Outoard	-- --	32 --	-- --	18 --	5.1 --	16 --
Underneath Aircraft	3.2 --	1.2 --	12 --	2 --	1.5 1.5	1.8 --
Open Area	151 180 --	89 87 95	63 65 --	65 57 66	-- -- --	-- -- --
Light Types	Metal Halide	Metal Halide	Fluorescent	Fluorescent	Metal Halide	Metal Halide

Recommendations for Bird Control in Flight Line Shelters

Rubb has indicated that birds do not tend to be a problem in their membrane structures. The fabric creates a low frequency vibration in the wind that birds do not like.

Scare Flags

- Constant movement dissuades birds form roosting
- Application:
  - Hang in upper trusses where birds would roost

Ineffective Solutions:

- Sonic/Ultrasonic Deterrence
- Hawk/Owl Mannequins
- Netting
- Predatory Raptors

Recommendations for Flight Line Shelter Maintenance

Rubb Building Systems and Alamo Drive Systems are planning to provide manuals that will address maintenance requirements following installation

Payback for Implementing Travel/Transport – Related Recommendations

Purchase Computer Stations:	$ 12,000
Purchase Radios:	$ 600
Purchase All-Weather Equipment Carts:	$ 7,200
Near Term Building 143 Modifications:	$ 7,200
Station 15 Equipment Storage:	$ 10,500
Total Cost:	$ 37,500

Annual Labor Cost Savings:	$135,000
Return on Investment:	28%
Payback Period:	3-4 months

Recommended Priority for Addressing all Action Items

- Replace 50t Pneumatic Jack
- Replace Ladder Truck
- Replace/Refurbish Hydraulic Power Cart
- Replace Forklift
- Lighting
- Replace Jet Starter Hose
- A/C PCA Hose
- A/C Trailer
- Build Extension Cable
- Tool Crib/Conference Room Modifications
- Computer Stations
- All Weather Equipment Carts
- Stock and Organize Equipment Trailer/Radios
- Building For Station 15
- Refurbish Panel Container
- Refurbishing Oxygen Cart
- Refurbishing Pickling Cart
- Refurbishing Nitrogen Cart
- Bird Repellant

Flight Line Modernization

START Monday, March 15, 2010

APR

M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S
15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

- Aaron Nuut
- Richard Clarke
- Taylor Bunnell
- Jason St. Marie
- Group

Current-state travel/transport paths
- FLT Equipment
- FLT Path Intensity
- FLP Equipment
- FLP Path Intensity

CAD existing-state travel/transport paths
- Campus-wide view
  - Pathways
- T-Box & Facility 143
  - Facility and equipment layout
  - Pathways

Problem Solutions
- Pathway optimizations
- Building/facility modifications
- Equipment needing replacement/refurbishment
- Rigid air duct storage/transport
- Mobile lighting
- Bird Deterrent

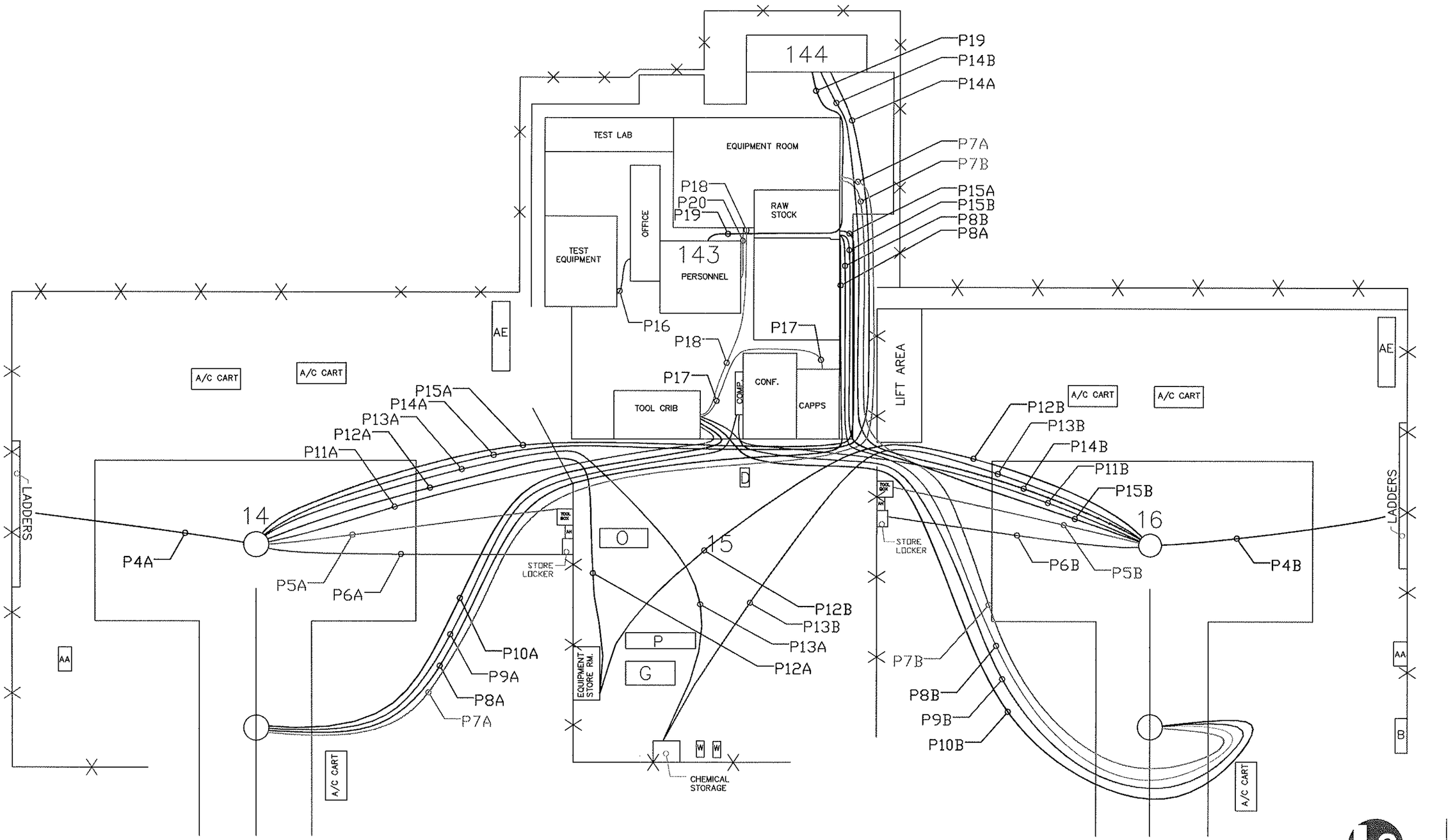
Preventative maintenance schedule

Future-state travel/transport paths
- FLT Path Intensity
- FLP Path Intensity

CAD future-state travel/transport paths
- Campus-wide view
  - Pathways
- T-Box & Facility 143
  - Facility and equipment layout
  - Pathways

PowerPoint presentation
- March 11-12 workshop overview
- Illustrated overview of problem solving methods
- Overview and analysis of exisiting operational state
- Recommendations for future
  - Travel/transport routes
  - Equipment with costs/benefits (prioritized)
    - [dependent on problem solutions]
  - Facility modification/building plans with estimated benefits
    - [dependent on problem solutions]
  - Preventative maintenance plan for shelters & drive equipment

Document Checks and Revision
- Presentation
- CAD Layouts

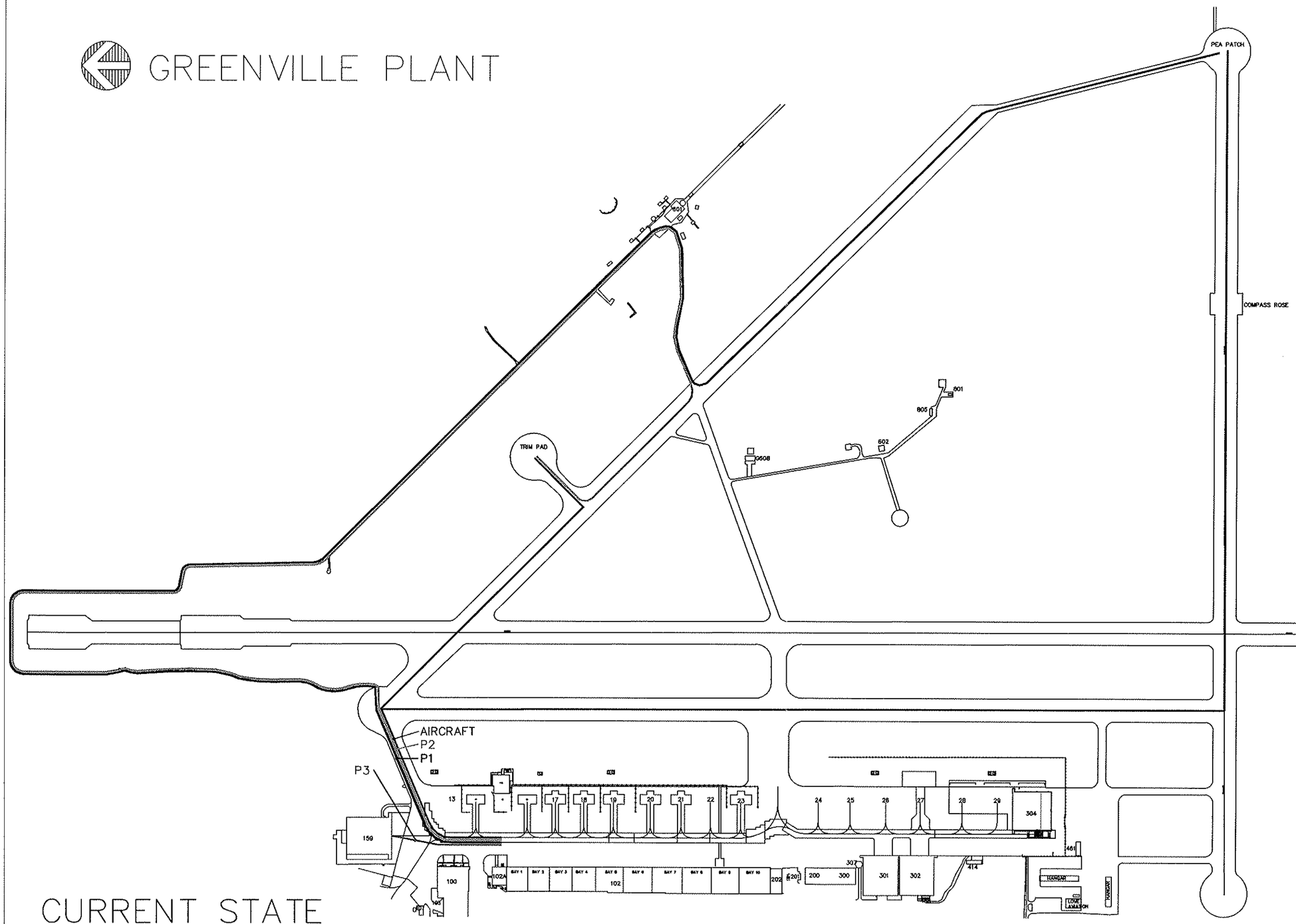


CURRENT STATE

GREENVILLE PLANT

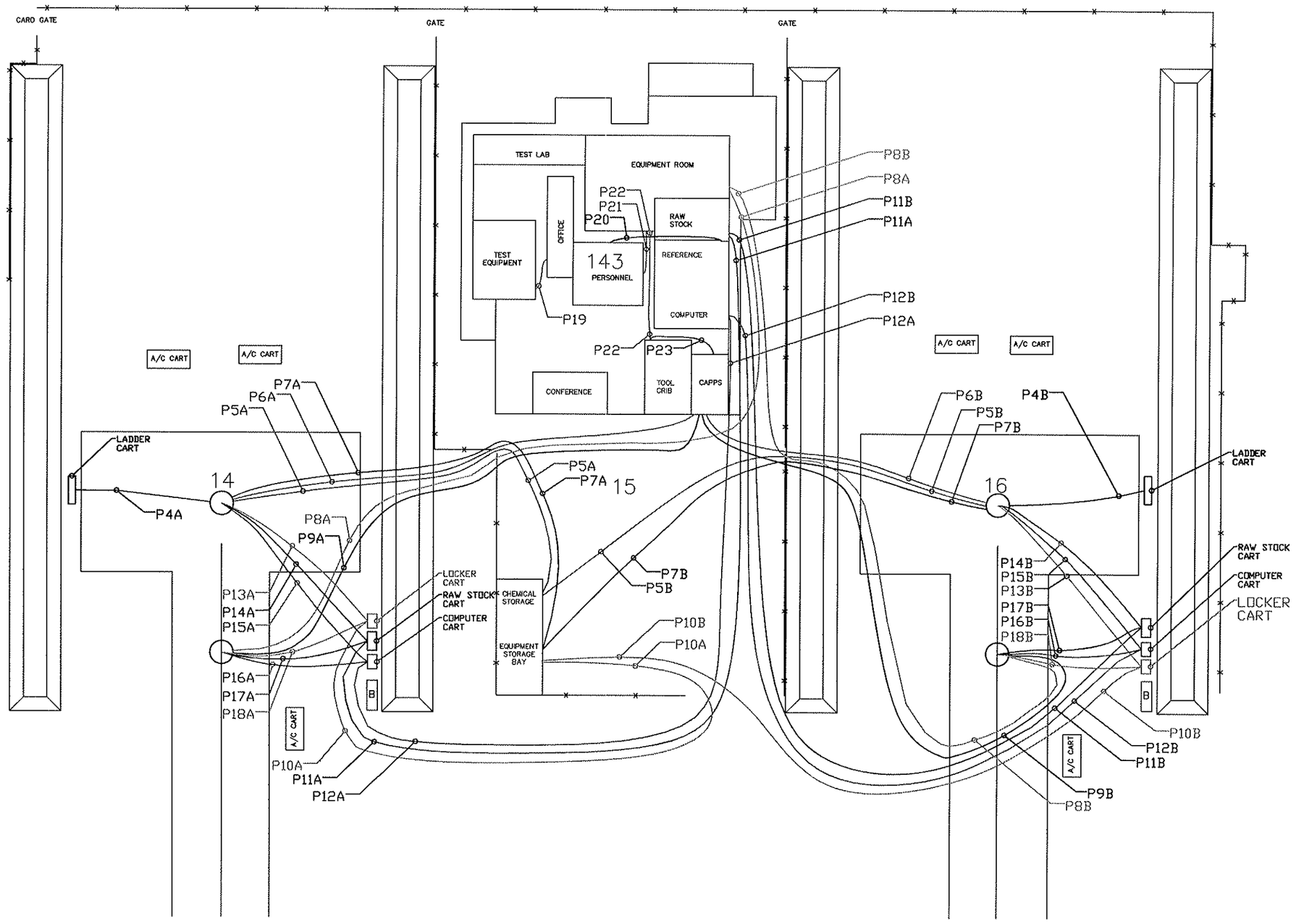
L3 communications Integrated Systems

GREENVILLE PLANT



CURRENT STATE

communications
Integrated Systems

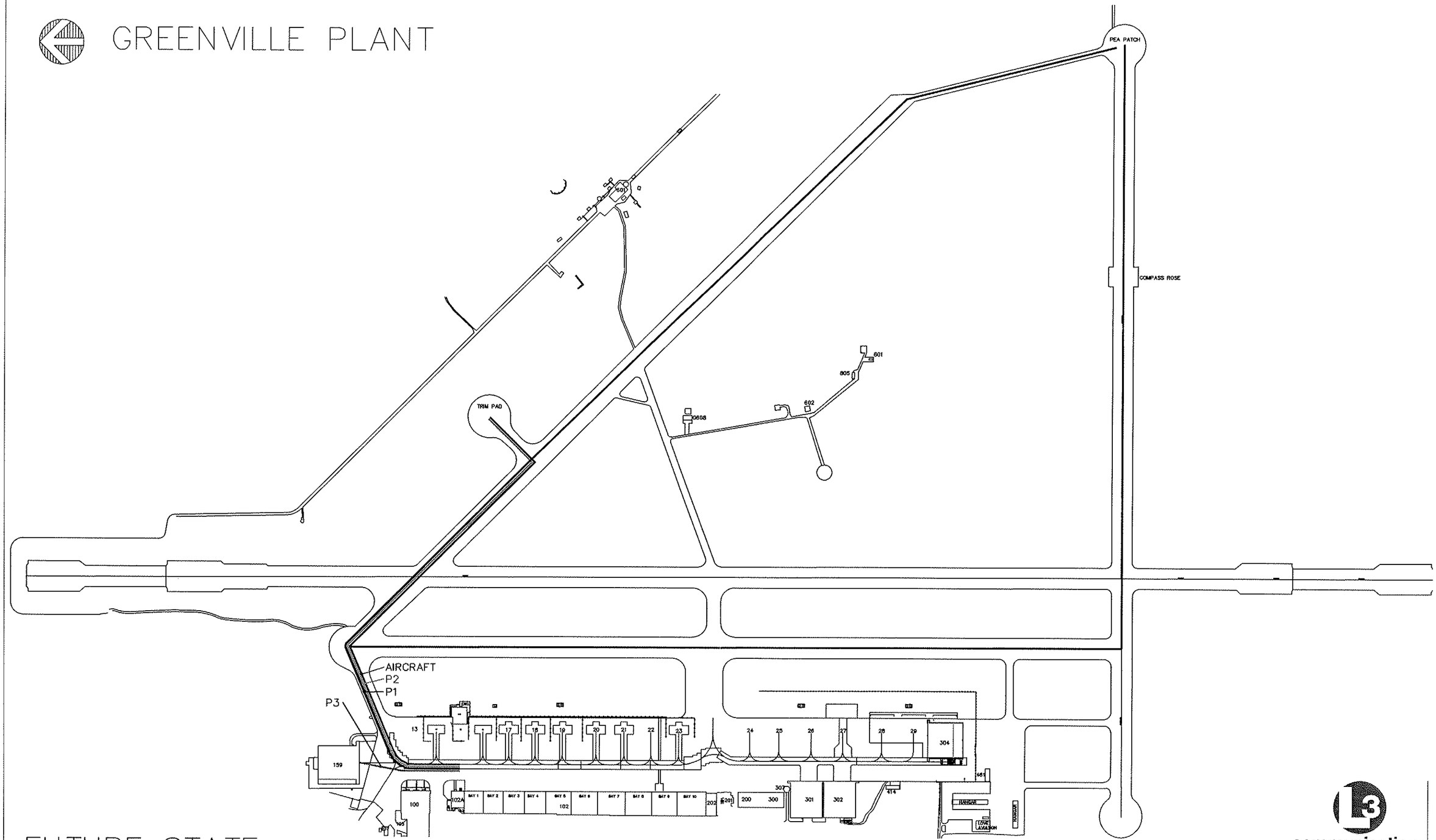


FUTURE STATE

GREENVILLE PLANT

L3 communications Integrated Systems

GREENVILLE PLANT



FUTURE STATE

communications
Integrated Systems