This is GE-Lynn

GE Aviation

2013

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Engineering and Mathematics
Practical Applications

GE Aviation Lynn, MA
Facilities Engineering
and
Edmund (Ted) Tarallo
Salem High School

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GE Lynn Facility

225 acres • 20 buildings

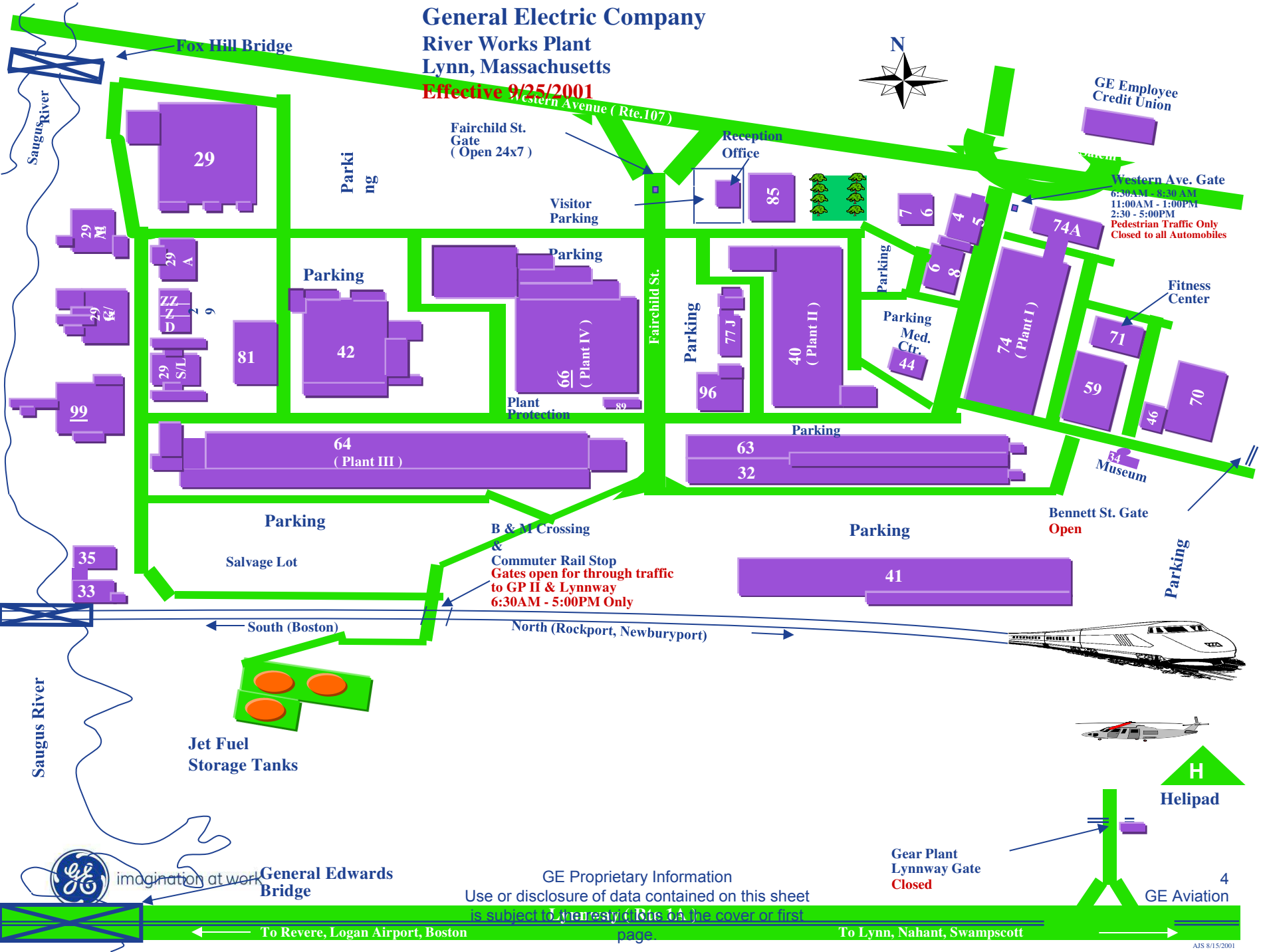
Prominent Role

- **Largest** Aviation manufacturing site
- **Represents** 2/3rd of MSO sales
- GE38, 701K, HF120 **Development**
- Key Product & Technology **Engineering**
- **Largest** GE Massachusetts business

Facility Highlights

- Mechanical Integrity Program
- Plant Electrical Updates

General Electric Company
River Works Plant
Lynn, Massachusetts
Effective 9/25/2001

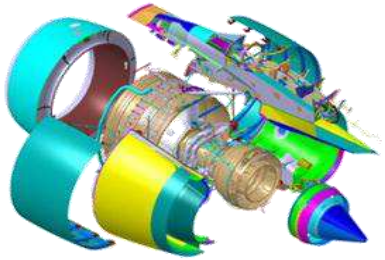


AJS 8/15/2001

What We Do….

We invent the future of flight, We lift people up & bring them home safely

Design



Manufacture

Assembly/Test

Facility Engineering

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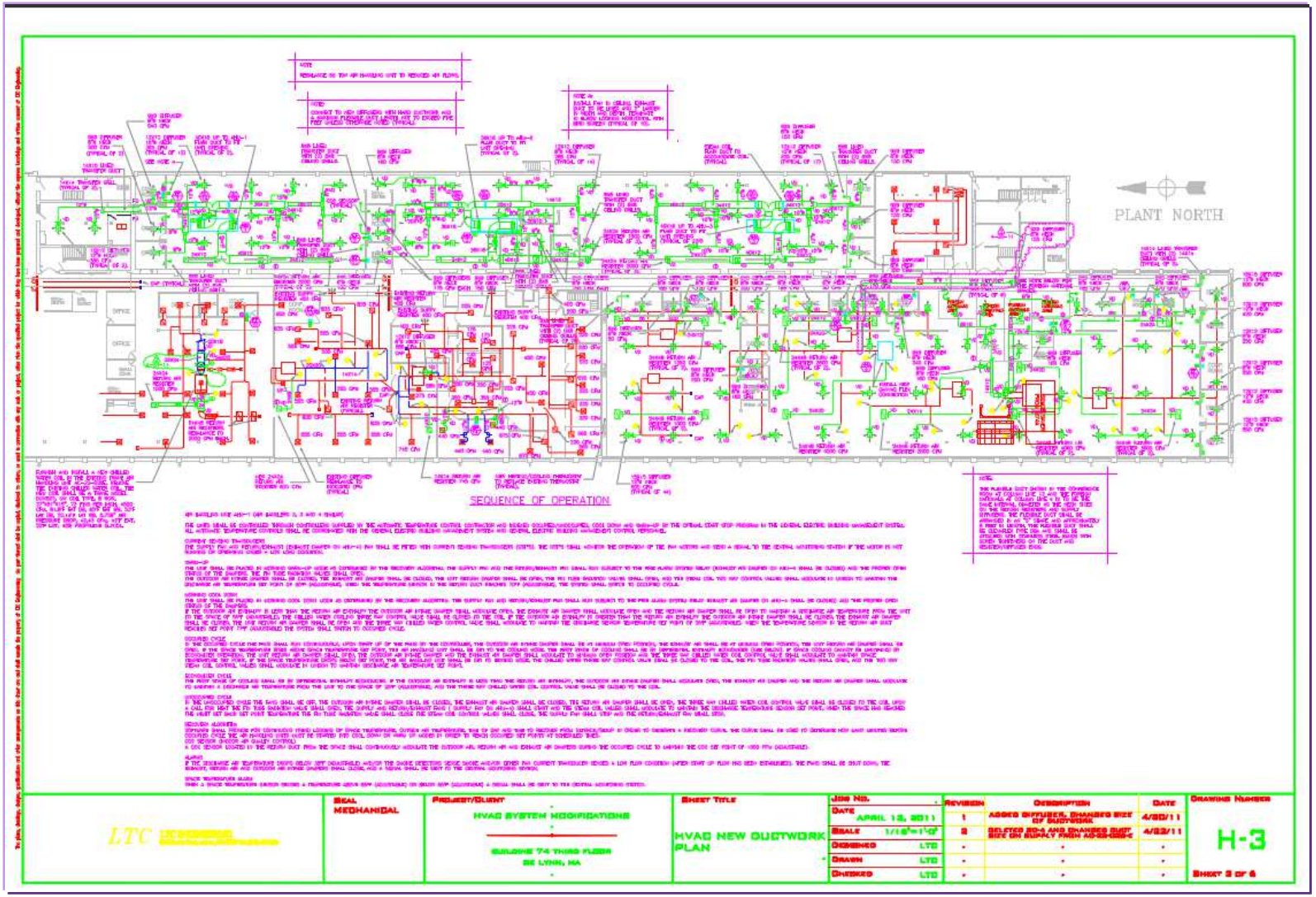
Building 74 3rd HVAC Project



Pressure Rating of Pipe

Pipe Burst Pressue/ Min Wall Thickness		(Barlow's Formula)
Solving for Pressure		
P =	#DIV/0!	Max. Working Pressure (psi)
E =		Longitudinal Joint Eff. Factor
s =		Material Strength(Allowable Stress) (psi)
t =		Wall Thickness (in)
do =		Outside Diameter (in)
SF =		Safety Factor (1.5 - 10)
A =		Allowance for Corrosion
P=2*s*E*(t -A)/ (do * SF)		
Closed Systems A = 0.025 in		
Open Systems A = 0.065 in		
Carbon Steel Seamless Pipe		
A53 Grade B		(1/4" - 26")
Yield	35 ksi	
E	1	
A106 Grade B		(1/4" - 30")
Yield	35 ksi	
E	1	
Stainless Steel		
A312 Grade TP304/TP316 (1/4" - 30")		
Yield	30 ksi	
E	0.85	

Solving for Thickness		
P =	100	Max. Working Pressure (psi)
E =	1	Longitudinal Joint Eff. Factor
s =	30000	Material Strength(Allowable Stress) (psi)
t =	0.085	Min Wall Thickness (in)
do =	6.065	Outside Diameter (in)
SF =	2	Safety Factor (1.5 - 10)
A =	0.065	Allowance for Corrosion
t = ((P*do*SF)/ (2 * S * E)) + A		

Corrosion Calculations

Corrosion Rate (ST) = $t_{previous}$ -t_{actual} / (time between $t_{previous}$ and t_{actual} (Years))

Remaining Life = t_{actual} - $t_{required}$ / corrision rate

$t_{initial}$ = the initial thickness at the same CML (Corrosion Monitoring Location) as t_{actual}.

Pressure Drop Calculations

Note:		**PIPE RUN**			A-B
	D	Selected Pipe Diameter (ft)			0.51
	d	Selected Pipe Diameter (in)			6.07
		Pipe Area (ft^2)			0.201
	V	Velocity in Pipe(ft/sec)			332.2194
	q	Total flow rate (ft^3/min)			4000
	q	Total flow rate (ppm)			323
	q	Total flow rate (pps)			5.4
	Re	Reynolds Number			1.087E+05
	ε/D	Pipe Roughness			2.967E-04
		Pipe Run Length (no Fittings)(ft)			**100**
		Fittings - Equivalent length for Pipe		QTY	TTL Eq L
		Entry loss	48		0
		12" 90 degree ell	30		0
		12" 90 degree long ell	19		0
		12" 45 degree ell	16		0
		4" 90 degree ell	10	3	30
		4" 90 degree long ell	6.7		0
		4" 45 degree ell	5.2		0
		3" 90 degree ell	7.5		0
		3" 90 degree long ell	5		0
		3" 45 degree ell	4		0
		12" Gate Valve	13		0
		4" Gate Valve	4.5		0
		3" Gate Valve	3.2		0
		12" Tee through run	20		0
		4" Tee through run	6.7		0
		3" Tee Through run	4		0
		Exit loss	64		0
		12" Check Valve	120		0
		4" Check Valve	40		0
		4" 3-Way Valve	20	1	20
		Dresser coupling			0
		4" Y fitting 45 degree	6		0
		12" Y fitting 45 degree	18		0
		Sudden Contraction			0
		Sudden Enlargement			0
		12" Strainer	180		0
		4" Strainer (4.5 psi)			0
		Gen. Heat Exchanger (8 psi)			0
		Blow out line with Strainer	35		0
		Total Friction Loss Fittings			**50**
	ρ	Density (lbm/ft^3)			0.517
		Temp in Pipe Run (°F)			140
	f	Friction Factor			0.016
	L_{eq}	**Total Equivalent Length**			**150**
	ΔP	**Total Pressure Drop (psi)**			35.36
	h_L	**Total Head (ft)**			79.82

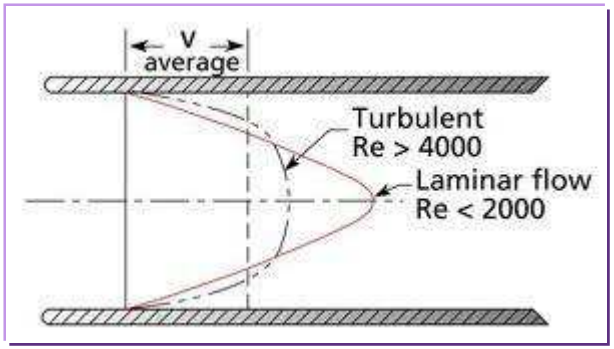
Bernoulli Equation – The total energy possessed by the fluid is the sum of its pressure, kinetic, and potential energies

$Et = Ep + Ev + Ez$

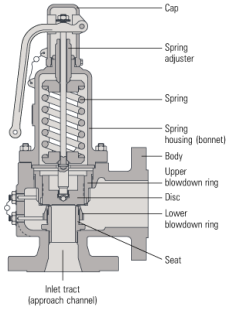
$Et = p/\rho + v^2/2 + zg$ (SI)

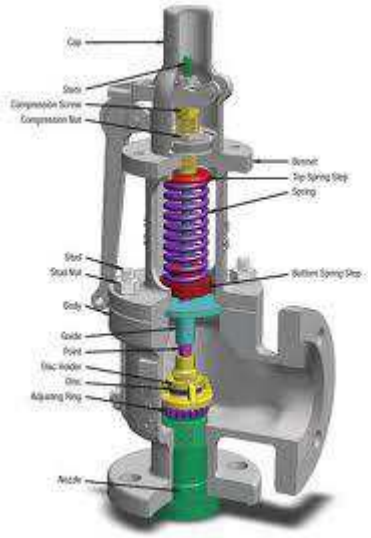
$Et = p/\rho + v^2/2*gc + zg/gc$ (US)

$(Ep + Ev + Ez)_1 + E_A = (Ep + Ev + Ez)_2 + E_E + E_f + E_m$



Pressure Relief Valve Calculations





Compressed Air Relief Valve Solving for Flow		
SCFM = A *6.32* C * K * P * KB / SQRT(T * G * Z)		
SCFM =	24833.1	
PPM =	2004.031	
PPS =	33.40052	
A =	12.56	SQ IN
SCFM =		Flow
T =	520	Abs Temperature Deg R (R=F+460)
M =	29.0	Molecular Weight
Z =	1	Compressibility Factor
C =	315	Coefficient determined from expression of ratio of specific heats (C=315 if value is not known)
K =	0.975	Effective Coefficient of Discharge
P =	125	Relieving Pressure (psia) (P=Set Pressure (psig) + Over Pressure (+10%) + atmospheric pressure (14.7 psia))
K_B =	1	Capacity correction factor due to back pressure (K_B=1.0 for atmospheric discharge)

Pressure Relief Device Inspection Checklist

QUALITY AND COMPLIANCE:

FACILITY ENGINEERING DATA MANAGEMENT PLAN

- **Maximo**
- **Inspection Checklist**
- **Manufacturer Information**
- **Calculations supporting the Design**
- **Inspection Data/Certifications**

Overpressure Protection Device Field Verification Data

Verified By:
Date Verified:
In Service Type:
Maximo ID :
Work Station #:
Date Installed:
Last Visual Inspection:
Repair Shop:
Repair Shop S/N:
Last Service Date:

Overpressure Protection Device Type:
- ▫ Atmosphere Vent
- ▫ Conservation Vent
- ▫ Other _____

Physical Plant Location:
(Bldg, Direction, Column)

Please Review Lock Out Tag Out (LOTO) Appendix

PRV

Mfg Name		Serial Number		NPS	
Set Pressure		Certified Capacity (as applicable)		ASME/NB Stamp	
Year Built		Lot #			

Checklist

Field Verified	Eng Review Req'd		Field Verified	Eng Review Req'd	
☐	☐	Check for evidence that the valve or device is leaking or not sealing properly.	☐	☐	Inspect inlet and outlet piping and verify that they are not smaller than the device inlet or outlet size
☐	☐	Seals for adjustments should be intact and show no evidence of tampering.	☐	☐	Check for possible hazards to personnel fromthe valve discharge or discharge pipe
☐	☐	Connecting bolting should be tight and all bolts intact. Verify the correct thread engagement is present.	☐	☐	Verify discharge piping is properly supported to prevent loading on the body of the device.
☐	☐	Examine valve and device for deposits or material buildup	☐	☐	Verify Pressure Gages are in place and a pressure test port is available
☐	☐	Evidence of rust or corrosion should be checked	☐	☐	Verify name plate information matches system capacity requirements
☐	☐	Check for damage frommisapplied parts	☐	☐	Verify that no intervening isolation valves are present between the pressure source and valve inlet or between the valve outlet and its point of discharge
☐	☐	Verify vessel capacity is greater then set pressure			

Accept: ☐ Reject: ☐

Remedial Actions:

Inspected By: _____ Date: _____
Engineering Review: _____ Date: _____
Authorized Inspector: _____ Date: _____
Approved By: _____ Date: _____

Follow Up Contact	Date:	Work Order Issued By:	Corrective Maintenance W.O. #:

Follow - On Corrective Maintenance Records Applicable

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QUESTIONS