



So You Want to be an Energy Engineer?





About Me

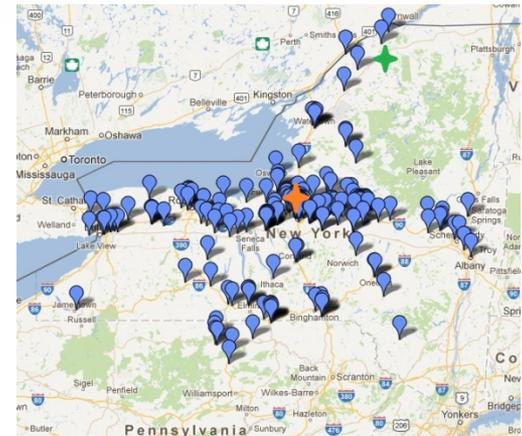
- ✧ B.S. Mechanical Engineering
May 2014
- ✧ M.S. Engineering Management
May 2016
 - Certificate of Advanced Study in
Sustainable Enterprises
- ✧ Started at IAC in October 2011
- ✧ Lead Student since December
2014
- ✧ Site visits: ~35





Our Center

- ✉ Founded in 2001, over 280 assessments completed
- ✉ Satellite Center at Clarkson University
- ✉ Student involvement from ~ 5 students to ~ 14 students
- ✉ Current Center Makeup
 - 1 graduate
 - 9 undergraduate
 - 4 undergraduate at satellite





Training At A Glance



- ☞ Manuals
- ☞ Gear
- ☞ Safety
- ☞ Non-Active Site Visit
- ☞ Bills
- ☞ Compressor ARs
- ☞ Goatastic
- ☞ Co-Lead
- ☞ Lead

- ☞ Training Management
 - Overseen by an experienced Engineer/Analyst (not the lead student)
 - Provides feedback for all analytical training



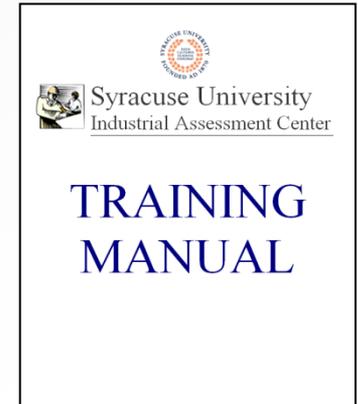


Manuals

- Manuals
- Gear
- Safety
- Site Visit
- Bills
- Comp. ARs
- Goatastic
- Co-Lead
- Lead

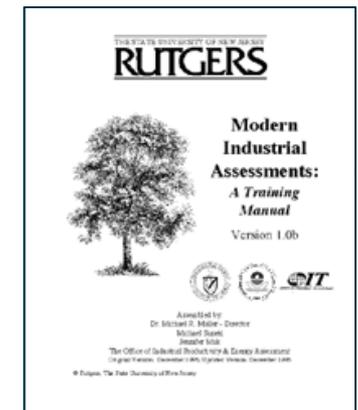
☞ Internal Training Manual

- Written by SU-IAC Alum
- Office Practices
- Database Access



☞ Rutgers Training Manual

- Technical Info
- Extremely important for young recruits



☞ Time Frame: ~2 weeks





Gear



- ∞ Become acquainted with common instruments used
- ∞ Completed before first site visit



- ∞ Syracuse Center of Excellence
 - Most recent gear training experience
 - Utilize equipment in mechanical/boiler rooms
 - Clarkson students involved





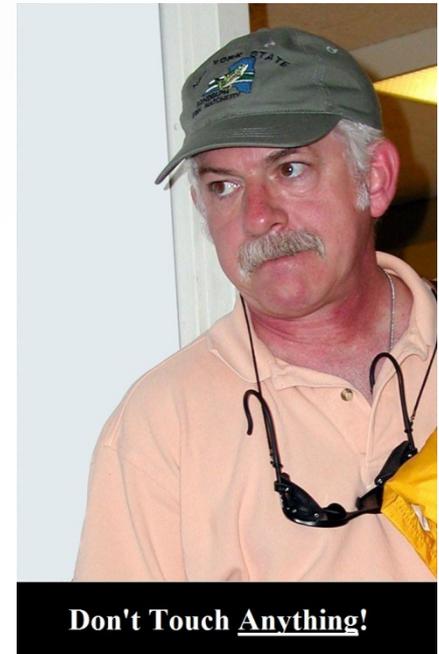
Safety

- Manuals
- Gear
- Safety
- Site Visit
- Bills
- Comp. ARs
- Goatastic
- Co-Lead
- Lead



∞ Safety protocol outlined in internal Training Manual

∞ Safety Orientation Training Video by Safety Advantage





Non-Active Site Visit

Manuals

Gear

Safety

Site Visit

Bills

Comp. ARs

Goatastic

Co-Lead

Lead

- ☞ Attend assessment with IAC team to observe
- ☞ Usually will count lights, exit signs etc.
- ☞ Experience an audit in a “no pressure” environment





Bills

Manuals

Gear

Safety

Site Visit

Bills

Comp. ARs

Goatastic

Co-Lead

Lead

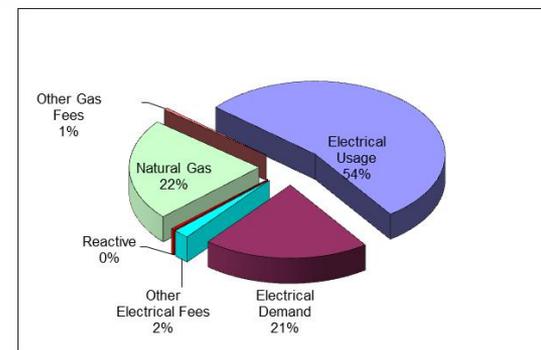


- Given a set of old utility bills
- Create spreadsheets for Electricity and Natural Gas to obtain average rates
- Time Frame: ~ 1 month

Period Ending	Electricity												Total Charges	Other Charges	Billed Total							
	Supply			Usage						Demand						Delivery			Reactive Charge	Usage (kWh)	kWh	Charge
	Usage (kWh)	\$/kWh	Supply Charge	Usage (kWh)	\$/kWh	Usage Charge	Demand (kW)	\$/kW	Demand Charge	Usage (kVA)	\$/kVA	Usage Charge				Usage (kWh)	\$/kWh	Charge				
Dec-02	348,400	\$0.0600	\$20,904	748,400	\$0.0133	\$4,668	630	\$14.97	\$9,421	211	\$0.85	\$179	338,400	\$0.0058	\$2,072	\$34,172	\$1,063	\$35,235				
Jan-03	366,000	\$0.0609	\$22,691	766,000	\$0.0136	\$4,826	666	\$14.97	\$9,820	185	\$0.88	\$168	356,000	\$0.0065	\$2,307	\$34,186	\$899	\$35,085				
Feb-03	336,000	\$0.0748	\$24,944	326,000	\$0.0148	\$4,758	664	\$14.97	\$9,840	195	\$0.85	\$168	326,000	\$0.0116	\$3,784	\$33,324	\$915	\$34,239				
Mar-03	359,000	\$0.1014	\$36,243	339,000	\$0.0144	\$4,724	656	\$14.97	\$9,800	195	\$0.85	\$168	339,000	\$0.0097	\$3,297	\$31,147	\$1,098	\$32,245				
Apr-03	299,600	\$0.0792	\$23,719	299,600	\$0.0156	\$4,674	668	\$14.97	\$10,000	193	\$0.88	\$164	299,600	\$0.0098	\$2,946	\$33,611	\$223	\$33,834				
May-03	300,000	\$0.0641	\$19,230	300,000	\$0.0147	\$4,410	676	\$14.97	\$10,120	203	\$0.88	\$172	300,000	\$0.0113	\$3,423	\$33,873	\$235	\$34,108				
Jun-03	362,400	\$0.0597	\$21,635	362,400	\$0.0143	\$4,995	680	\$14.97	\$10,180	209	\$0.85	\$178	362,400	\$0.0065	\$2,362	\$35,152	\$924	\$36,076				
Jul-03	372,800	\$0.0693	\$25,836	372,800	\$0.0138	\$5,144	704	\$14.97	\$10,529	213	\$0.88	\$181	372,800	\$0.0071	\$2,637	\$39,063	\$987	\$40,050				
Aug-03	347,600	\$0.0666	\$23,147	347,600	\$0.0147	\$5,110	692	\$14.97	\$10,252	213	\$0.88	\$181	347,600	\$0.0071	\$2,637	\$39,063	\$987	\$40,050				
Sep-03	401,200	\$0.0723	\$29,006	401,200	\$0.0147	\$5,900	704	\$14.97	\$10,529	213	\$0.88	\$181	401,200	\$0.0071	\$2,637	\$41,646	\$987	\$42,633				
Oct-03	312,800	\$0.0622	\$19,556	312,800	\$0.0147	\$4,599	680	\$14.97	\$10,180	209	\$0.88	\$172	312,800	\$0.0071	\$2,637	\$37,199	\$987	\$38,186				
Nov-03	314,400	\$0.0621	\$19,500	314,400	\$0.0147	\$4,626	680	\$14.97	\$10,180	209	\$0.88	\$172	314,400	\$0.0071	\$2,637	\$37,369	\$987	\$38,356				
Totals	4,078,800	N/A	\$246,661	8,039,600	N/A	\$1,171,111	7,024	\$14.97	\$104,858	2,391	\$0.88	\$456	8,039,600	N/A	\$117,111	\$820,773	\$2,391	\$823,164				
Averages	339,900	\$0.0661	\$20,555	339,900	\$0.0147	\$4,626	704	\$14.97	\$10,529	213	\$0.88	\$181	339,900	\$0.0071	\$2,637	\$37,369	\$987	\$38,356				

Period Ending	Natural Gas												Total Charges	Other Charges	Total Billed				
	Supply			Demand						Delivery						Delivery Service Adj	Usage (Therm)	\$/Therm	Charge
	Usage (Therm)	\$/Therm	Supply Charge	Usage (Therm)	\$/Therm	Usage Charge	Usage (Therm)	\$/Therm	Usage Charge	Usage (Therm)	\$/Therm	Usage Charge							
Dec-02	16,457	\$0.5038	\$8,291	5,000	\$0.1547	\$774	11,457	\$0.0458	\$524	16,457	\$0.0115	\$188	\$8,615	\$26	\$9,615	\$286	\$9,901		
Jan-03	16,698	\$0.5147	\$8,594	5,000	\$0.1547	\$774	11,698	\$0.0458	\$535	16,698	\$0.0116	\$192	\$8,786	\$26	\$8,952	\$191	\$9,143		
Feb-03	18,300	\$0.5247	\$9,599	5,000	\$0.1547	\$774	13,300	\$0.0458	\$609	18,300	\$0.0113	\$205	\$11,754	\$26	\$11,780	\$226	\$12,006		
Mar-03	19,138	\$0.6975	\$13,348	5,000	\$0.1547	\$774	14,138	\$0.0458	\$647	19,138	\$0.0113	\$215	\$14,775	\$283	\$15,058	\$283	\$15,341		
Apr-03	15,707	\$0.6586	\$10,368	5,000	\$0.1547	\$774	10,707	\$0.0458	\$490	15,707	\$0.0113	\$176	\$11,754	\$282	\$12,036	\$282	\$12,318		
May-03	15,034	\$0.7620	\$11,468	5,000	\$0.1547	\$774	10,034	\$0.0458	\$459	15,034	\$0.0111	\$166	\$11,297	\$243	\$11,540	\$243	\$11,783		
Jun-03	13,696	\$0.7712	\$10,485	5,000	\$0.1547	\$774	8,696	\$0.0458	\$393	13,696	\$0.0115	\$157	\$11,639	\$224	\$11,863	\$224	\$12,087		
Jul-03	13,969	\$0.6951	\$9,703	5,000	\$0.1547	\$774	8,969	\$0.0458	\$410	13,969	\$0.0115	\$159	\$10,935	\$210	\$11,145	\$210	\$11,355		
Aug-03	12,002	\$0.5937	\$7,125	5,000	\$0.1547	\$774	7,002	\$0.0458	\$320	12,002	\$0.0115	\$138	\$8,263	\$159	\$8,422	\$159	\$8,581		
Sep-03	13,332	\$0.5443	\$7,257	5,000	\$0.1552	\$776	8,332	\$0.0459	\$383	13,332	\$0.0115	\$153	\$9,462	\$163	\$9,625	\$163	\$9,788		
Oct-03	11,795	\$0.6254	\$7,376	5,000	\$0.1564	\$782	6,795	\$0.0463	\$314	11,795	\$0.0115	\$135	\$8,514	\$164	\$8,678	\$164	\$8,842		
Nov-03	13,463	\$0.6172	\$8,290	5,000	\$0.1564	\$782	8,463	\$0.0463	\$392	13,463	\$0.0111	\$155	\$9,538	\$163	\$9,701	\$163	\$9,864		
Totals	179,502	N/A	\$117,111	50,000	N/A	\$7,774	179,502	N/A	\$8,200	179,502	N/A	\$2,391	\$1,171,111	\$2,391	\$1,173,502	\$2,391	\$1,175,893		
Averages	14,959	\$0.6457	\$9,759	5,000	\$0.1555	\$777	14,959	\$0.0460	\$332	14,959	\$0.0114	\$167	\$11,711	\$191	\$11,902	\$191	\$12,093		

Utility	Annual Cost	Annual Usage				Average Cost			
		Billed Units		MMBtu		Billed Units		\$/MMBtu	
		Billed Units	\$/Billed Unit	MMBtu	\$/MMBtu	Billed Units	\$/Billed Unit	MMBtu	\$/MMBtu
Electrical Usage	\$315,742	4,078,800	kWh	13,921	MMBtu	\$0.0776	\$/kWh	\$22.73	\$/MMBtu
Electrical Demand	\$120,778	8,068	kW	N/A	N/A	\$14.97	\$/kW	N/A	N/A
Other Electrical Fees	\$11,456	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Reactive	\$2,032	2,391	REVA	N/A	N/A	\$0.8500	\$/REVA	N/A	N/A
Natural Gas	\$130,954	179,502	Therms	17,950	MMBtu	\$0.6929	\$/Therm	\$6.94	\$/MMBtu
Other Gas Fees	\$2,612	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	\$583,574	N/A	N/A	31,871	MMBtu	N/A	N/A	N/A	N/A





Compressor ARs

Manuals | Gear | Safety | Site Visit | Bills | Comp. ARs | Goatastic | Co-Lead | Lead



- ☞ Use billing analysis
- ☞ Most common ARs
 - Leaks
 - Duct Outside Air
 - Reduce Line Pressure

☞ Get a feel for writing ARs

☞ Time Frame: ~ 1 month

Assessment Recommendation # 1
Repair Leaks in Compressed Air System

Assessment Recommendation Summary					
ARC#	Annual Resource Savings	Total Annual Savings	Capital Cost	Other Cost	Simple Payback
2.4276.2	Electricity: 168,397 kWh	\$15,829	\$660	\$10,500	0.7 years

Current Practice
During the plant visit it was observed that the compressor outlet pressure was approximately 125 psi.¹ Plant personnel estimated approximately 60 total air leaks within the facility.

Recommended Action
It is recommended that leaks in the compressed air system be repaired.

Assessment Recommendation # 2
Duct Outside Air to Compressor

Assessment Recommendation Summary					
ARC#	Annual Resource Savings	Total Annual Savings	Capital Cost	Other Cost	Simple Payback
2.4221.2	Electricity: 275,462 kWh	\$25,921	\$0	\$0	# years

Current Practice
It was observed during the site visit that the plant's air compressors are drawing air from their surroundings. The following table details the important compressor data.

Horsepower (hp)	Intake Temperature (°F)	Outdoor Temperature (°F)	Load Factor	Efficiency	Annual Hours of Operation
250	134	70	0.93	0.83	8,424
150	127	70	0.79	0.85	8,424
100	123	70	0.21	0.83	300

Recommended Action
It is recommended that outside air be ducted directly into the compressor intake. Outside air is, on average, cooler and denser than indoor air. Using outdoor air for compression can reduce the energy requirements of the compressor.

Assessment Recommendation # 3
Reduce Compressed Air System Line Pressure

Assessment Recommendation Summary					
ARC#	Annual Resource Savings	Total Annual Savings	Capital Cost	Other Cost	Simple Payback
2.4231.2	Electricity: 68,234 kWh	\$6,421	None	None	Immediate

Current Practice
It was observed during the site visit that the plant's air compressors may be running at a higher pressure than the facility requires. The following table provides important information for each of the compressor units.

Horsepower	Load Factor	Efficiency	Current Operating Pressure (psi)	Proposed Operating Pressure (psi)	Annual Operating Hours
250	0.95	0.85	125	90	8,424
150	0.79	0.86	125	90	8,424
100	0.21	0.85	125	90	300

Recommended Action
It is recommended that the line pressure be reduced to the facility. The following figure shows graphically the relationship between horsepower (DHP) reduction and discharge pressure. The line pressure should be gradually reduced in order to prevent any unforeseeable problems that may occur.

fractional reduction in energy, from the equation

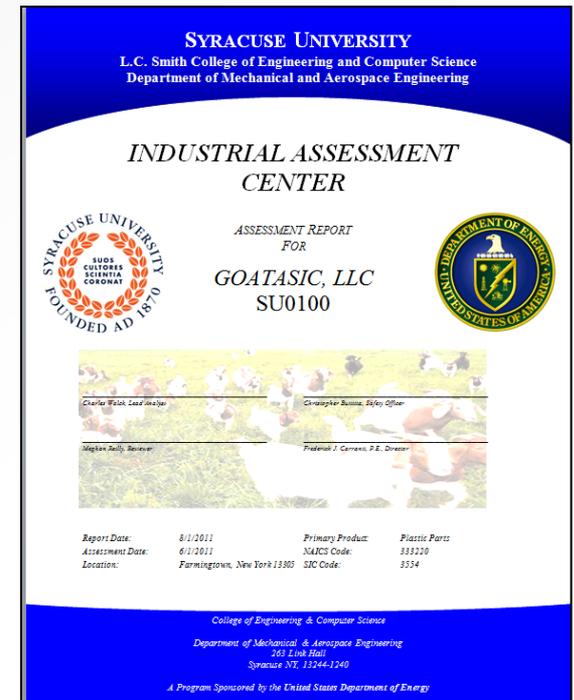
134°F
70°F



Goatastic

- Manuals
- Gear
- Safety
- Site Visit
- Bills
- Comp. ARs
- Goatastic
- Co-Lead
- Lead

- Mock report write-up
- Use billing analysis
- Given site notes
- Write ~15 common ARs
- Emphasis on formatting
- Time Frame: ~ 2 months





Co-Lead

Manuals

Gear

Safety

Site Visit

Bills

Comp. ARs

Goatastic

Co-Lead

Lead

- ∞ Must complete all other parts of training!

- ∞ Assigned a “co-lead” with an experienced analyst
 - Walks through pre-assessment process
 - Assists in client de-brief
 - Reviews final report and assists with upload



- ∞ **IMPORTANT:** Trainee acts as lead and “co-lead” supports.



Lead



- ☞ Training is complete
- ☞ Completely independent and responsible for client/report
- ☞ Move on to other tasks
 - Client search
 - New ARs
 - New technology





Closing Remarks



- ∞ Total Training Time ~ 6 months depends on:
 - Year of study (undergrad/grad)
 - Time of year (summer/school year)

- ∞ Evolving Process
 - Student Feedback
 - Hands on/analytical balance
 - Interactive Training





Questions?

