Attachment # 1

AAM Energy Policy

Commitment

Escalating and volatile energy cost compromises American Axle & Manufacturing profitability. Therefore, as part of its manage for profit strategy, AAM is committed to serious and responsible energy management and will practice energy efficiency throughout its facilities, reducing energy costs by using and purchasing it in the most cost-effective ways possible within safe practices and environmental conditions.

Objective

AAM will continuously improve its energy performance where possible. It will implement this policy without compromising safety, reliability, and environmental conditions by establishing and implementing an effective Energy Awareness and Management Program.

Goals

- Incorporate energy efficiency in daily activities to maximize the possibility of identifying energy saving opportunities.
- Use energy as efficiently as practicable throughout the Company's production and non-production facilities.
- Evaluate the plants' current equipment to identify energy saving opportunities.
- Incorporate energy efficiency into the selection of new equipment for production and non-production facilities.
- Purchase energy from suppliers that best fit AAM cost and quality needs.
- Reduce pollution, particularly CO2 emissions indirectly caused by AAM energy use.

Applicability

This policy shall apply to all American Axle & Manufacturing facilities and subsidiaries, business units, and associates, worldwide.

Administration

The AAM Energy Team will be responsible for administrating this policy, as well as evaluating and updating the policy to reflect changing needs and priorities.

Attachment # 2

ENERGY STAR Partnership Letter

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

March 10, 2008

Mr. John Bellanti
Group Vice President, Manufacturing Services
Capital Planning & Cost Estimating
American Axle and Manufacturing
One Dauch Drive
Detroit, Michigan 48211-1198

Dear Mr. Bellanti:

Congratulations on your decision to join ENERGY STAR® and over 1,500 organizations nationwide that recognize the value of strategic energy management. By making a commitment to improved energy performance, American Axle and Manufacturing is on the way to enhancing its bottom line while demonstrating environmental leadership.

We at the Environmental Protection Agency applaud your decision to become a part of ENERGY STAR and look forward to working with your corporation's energy director, Afif Bitar to improve American Axle and Manufacturing's energy performance and promote its participation in the partnership. Your decision is an excellent example of how government and industry can work together in a voluntary manner to promote energy efficiency as a smart business strategy and to show exceptional environmental leadership. Welcome!

Sincerely,

Elizabeth Dutrow

Elizabeth Dutrow
Director, Industrial Sector Partnerships
ENERGY STAR

cc: Afif Bitar

Attachment # 3

Scorecard Report for September & 3rd QTR 2008

Bitar, Afif

From: Bitar, Afif
Sent: Sunday, November 09, 2008 7:50 PM
To: Moriguchi, Inacio; Waller, Larry; Andreski, Dennis; Maxwell Tim; Trathen Michael J.; Petterle, Larry; Yezback, Gregory; Campbell, James; Szymanski, John; Kenyon, Todd; Vanderhoof, Daniel; Griffin, Peter; Fry, Tom; Romano, Kevin; Wrikeman, Jeff; Burke, Thomas (Colfor); 'Kanotz, Dave'; Reinhard Lance; Barbosa, Michel; Smith, Kevin; Guaresimo, David; Morales, Daniel; Joseph, Donald; Fang, Kevin; Coetzee, Mike; Kerr, Martin; Forshee, Kim; Figielski, Michal; Liburdi, Samuel; Rupe, John; Samuels, Dean; Steyer, Glen; Sisler, Bob; Catoni, Matthew; Isambert, Ovelio
Cc: Dauch, Richard E.; Dauch, David C.; Rahangdale, Yogen; Bellanti, John; Howell, Curt; Culton David; Jerge, John; Delanoy, Thomas; Willemse, Norman; Sofia, John; Monich, Al; Barrett, Mark
Subject: September and 3rd QTR 2008 Scorecard:

September 2008 has been an excellent month as far as energy curtailment. Ten out of 14 plants went beyond the **5%** energy reduction goal. Overall AAM achieved **11.1%** reduction. This is the result of hard-working teams paying closer attention to energy savings opportunities before it is too late. These efforts portraits how serious the energy curtailment program has been taken by the plants' managers, leading to about **$610,449** in energy savings. Corporate wide, this result is also reflected by the lower energy intensity and sales. Sales went down from $259.5M in Sep-07 to $201.7M in Sep-08. The corporate overall energy intensity decreased from 1 MBtu/$ Sales in Sep-07 to 0.94 MBtu/$ Sales in Sep-08. The table below lists the plants that managed to reduce their energy intensity despite lower sales. **For the Month of September Malvern is the Star in Energy Curtailment, Congratulations to Mr. Peter Griffin, Tom Fry and their team, they achieved over 40% in Energy reduction.**

	Sales		Delta Sales		MBTU/$ sales	
	Sep-07	Sep-08			2008	2007
TF	$12,139,995	$10,498,114	-13.52%	($1,641,881)	1.57	2.61
Malvern	$5,810,804	$4,332,903	-25.43%	($1,477,901)	0.98	1.32
Minerva	$5,504,513	$5,349,968	-2.81%	($154,545)	1.31	1.55

Sep-08 Scorecard Highlights:
Production Facilities

- **DGA & DF:** The Detroit team, under the leadership of Mr. Inacio Moriguchi, has been taking serious action to minimize energy usage. We see the results of recent implementation of energy curtailment practices in September 2008. DGA and DF reduced their electrical load by **12.55%** and **4.96%** respectively. Similarly, DF reduced its NG load by **1.9.** We expect the Detroit team to continue with the hard work to achieve further progress. Overall, DGA and DF reduced their energy usage by **5.3%** and **1.6%** respectively.

- **Detroit Steam:** We see through historical data that steam has not been curtailed in respect with production. In Sep-07 Detroit used 21,341 klbs for $106.8 million in sales while in Sep-08 20,966 klbs were used for $64.8 million in sales. A recent energy assessment conducted by a representative of the DOE and AAM personnel pointed out the importance of effectively controlling the supply of steam to the doughnut heaters and washers. In addition, it was observed several steam leaks, two of which were significant and the parts to repair are on order. It is expected that the Detroit team uses the results from the ESA assessment to develop more effective strategies of reducing or eliminating the use of steam for space heating and process.

- **MSP** reduced its energy usage by **22.2%**. In May-07 the plant used 324 MCF of NG for an average outdoor air temperature of 62F while in Sep-08 only 21 MCF were used for about the same temperature, 63F. Similarly, in May-07 the plant used more electricity than in Sep-08 for lower sales, $7.4 million in 07 Vs $8.4 million in 08.

- Starting in Sep-08 **Oxford Forge** is included in the scorecard report. The plant will be evaluated based on historical data gathered from Powerlogic (Power monitoring software). The electrical trend for the cooling tower confirmed that the plant made a good effort to properly shut it down during non production hours. On the other hand, attention needs to be paid for lighting and compressed air usage. The Sep-08 loading trend indicates that the lighting load was not reduced during weekends. Looking at the total historical demand, we don't see correlation of total load with lighting. This indicates that the lights were on during non production hours. From Sep the 20th until the Sep the

22nd, the total load was reduced to approximately 400kW of which over 100kW were due to lighting. Regarding the compressed air (CA), per discussion with Fred Hamizadeh, it is not required as long as the furnace is not cycling; so it can be shut down during non production hours such as weekends. In doing so, AAM would save about $200 to $300 per day. Assuming 6 days per month, $1,200 to $1,800 could be saved. Therefore, we see more opportunities regarding the excess of compressed air which need to be addressed ASAP. We strongly advise to investigate and implement this action if feasible. Also, we will work with the plant to set the 150 HP compressors in good condition to switch the load to it.

- **Three Rivers** exceeded the energy reduction goal with **22%**. The plant's effort under the leadership of Mr. Yezback can be seen through comparing the NG usage in Sep-08 with historical data. In Jul-06 the plant used more NG (14313 MCF) for about the same sales ($21.7 million). Considering that July is a shutdown month, these results portrait the important progress that the plant has accomplished by implementing effective curtailment actions.

- In **Tonawanda Forge** some furnaces and other production equipment have been shut down due to the idling process resulting in lower energy usage in Sep-08. Sales dropped from $12.1 million to $10.5 million. On the other hand, under the leadership of Mr. Vanderhoof, the plant's personnel were able to lower the energy intensity from 2.61 MBtu/$ Sales to 1.57 MBtu/$ Sales through the proper implementation of curtailment actions. In Sep-08 the plant exceeded the energy reduction goal with **15.7%**. TF will be included in the score card report until October 2007 due to the idling process.

- **CKT** reduced its electrical load by **24.15%**, but a **5%** increment was observed in NG. This is consistent with the results from the past few reports, which is related to furnaces operation. Hence, it is advised to develop a plan of action to identify lost opportunities and evaluate the possibilities of shutting down furnaces when production volumes are low. Overall CKT reduced its energy usage by **16%**.

- In **Malvern** lower sales drives higher overhead. Yet, the plant under the leadership of Mr. Griffin and Mr. Fry managed to reduce its energy intensity as shown on the table above. The plant presents an important reduction in electricity and NG load, 41.99% and 35.26% respectively, for a total of **40.8%** reduction. The plant informed that the stress release furnace is being used about one week per month and that the boiler for the coating process is being shut down for the third shift. The operating time of this equipment was reduced from 24/7 to 16/5. Shutting down equipment instead of idling during non production hours is highly recommended when feasible since it leads to higher reduction, so savings are maximized. We encourage all plants to follow this action.

- Similarly, **Minerva** also managed to reduce its energy intensity despite of lower sales. The plant exceeded the 5% energy reduction goal with **11.5%**.

- **Salem** reduced its energy usage by **24.5%**. Historical data confirmed the important progress that the plant has achieved since last year. For instance, in Sep-07 the plant used 1387 MCF of NG for $2.1 million in sales and average outdoor air temperature of 64F, but in Sep-08 only 910 MCF were used for higher sales ($2.5 million) and about the same temperature (63F). Similarly, the plant used less electricity in Sep-08 than in Sep-07.

- **Brazil** reduced its energy intensity at about 0.55 Mbtu / $ Sales for slightly higher sales. This is expected due to lower overhead. Yet, the statistical model suggests that the plant used less energy than what was expected under actual production and weather conditions. The energy reduction goal was exceeded with **12.6%**.

- **Mexico** under the leadership of Mr. Kevin Smith reduced its energy usage by **11.6%.** Historical data confirms this result. In Sep-07 the plant used 7.6 MWh for $64.2 million in sales while in Sep-08 5.4 MWh were used for $68 million. Similarly, in Sep-07 more NG was used than in Sep-08. This suggests that the reduction in energy intensity is not only for lower overhead but also for effective curtailment.

- According to historical data, no issues were found in **Albion**. The plant exceeded the energy reduction goal with **11%**.

- **China** and **Poland** are small plants that run on very low elect and NG load during times of low sales. For instance, in Sep-08 Poland ran on an average of 44kW while China ran on 107kW. Therefore, any small reduction or increment in the load won't affect the total reduction and savings corporate wide, so no issue is reported at these sites.

Non Production Facilities

- The **WHQ** reduced its electricity and natural gas usage, but in this opportunity it fell short from the 5% energy reduction goal. Overall, the energy usage was reduced by **3.9%**. The fact that the goal has been reached in previous months indicates that some savings opportunities were missed. The Average outdoor air temperature should have not been a factor since it was around 66F for both Sep-07 and Sep-08.
- In Sep-08 the **Training Center** and the **Quality Center** presented significantly lower electrical consumption which leads to **22.5%** and **34.3%** total reduction respectively. The statistical model confirms that both facilities used less energy than what was expected under actual weather conditions.

3rd QTR Scorecard Highlights:
The corporate wide effort paid to energy among all AAM plants was seen in the 3rd QTR scorecard analysis, leading to excellent results. During July, August, and September AAM saved **$1,459,073** in energy. The energy reduction goal was exceeded by 4.4 points with **9.4%** reduction. Although corporate sales dropped from $828.6 million to $579.3 million, and some steam distribution issues found in Detroit, AAM maintained its energy intensity around 1 MBtu / $sales. This is due to the great work of some plants, such as **Tonawanda Forge, Salem, Mexico, and Albion,** which managed to reduce their energy intensity despite of lower sales during the 3rd QTR of the year. Overall AAM reduced its CO2 emission by approximately **11,993 tons**. The table below summarizes the total savings and CO2 reduction in 2008 from January until September.

2008	1st QTR			2nd QTR			3rd QTR			YTD
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	
Energy Savings	$125,555	$294,238	$71,201	$139,047	$298,584	$87,085	$403,621	$445,003	$610,449	$2,474,783
	$490,994			$524,716			$1,459,073			
CO2 Reductions (tons)	1,139	1,885	554	1,042	1,838	544	2,601	3,651	5,741	18,995
	3,578			3,424			11,993			

Significant Actions

- Due to escalating steam cost, it is imperative to create an action plan to minimize or eliminate the steam usage in Detroit.
- It is expected that all plants follow Malvern practices as far of shutting down production equipment instead of idling it during non production hours.
- We see more opportunities to reduce the compressed air load at Oxford Forge. As mentioned in the Sep-08 scorecard report, it strongly advised to evaluate the possibility of shutting the compressed air down while the furnace is not cycling during non production hours.
- The fact that the WHQ didn't reach the 5% energy reduction goal, even though the outside air temperature was around 70F for both the 3rd QTR 2007 and 2008, implies that some savings opportunities were missed. Hence, the actions implemented during this period of time should be evaluated to identify corrective measures.
- Tonawanda Forge and Detroit Forge will be included in the scorecard report until October 2008 due to the idling process.

Scorecard Summary Tables
The tables below summarize the September and 3rd QTR 2008 energy scorecard results for production and non production facilities.

September Score Card

Site	Energy Consumption									Energy Scorecard September 2008		
	Actual			Actual Vs Adjusted Budget (%)			Energy Usage in MMBtu			MBTU/$ sales		Rating
	Elect (kWh)	NG (MCF)	Steam (1000 lbs)	Elect	NG	Steam	Adjusted Usage	Actual Usage	% Reduction	2008	2007	
DGA	10,704,502	9,022	12,580	-12.55%	4.96%	13.87%	61,407	58,125	-5.3%	0.97	0.75	
DF	1,369,415	6,991	8,386	-25.69%	-1.90%	20.44%	20,377	20,049	-1.6%	4.22	3.22	
MSP	2,434,880	21		-21.93%	-69.36%		10,708	8,328	-22.2%	0.99	1.43	
Oxford Forge	489,443	740						2,410				
3R	3,729,750	10,139		-25.01%	-17.83%		29,309	22,865	-22.0%	1.05	0.92	
TF	3,869,469	3,301		-17.28%	-8.92%		19,585	16,504	-15.7%	1.57	2.61	
CKT	784,199	1,426		-24.15%	5.00%		4,886	4,102	-16.0%	3.60	3.44	
Malvern	1,008,384	800		-41.99%	-35.26%		7,167	4,241	-40.8%	0.98	1.32	
Minerva	1,660,800	1,331		-12.65%	-6.42%		7,910	6,998	-11.5%	1.31	1.55	
Salem	563,772	910		-23.20%	-27.20%		3,755	2,834	-24.5%	1.13	1.75	
Brazil	902,166	620		-13.59%	-7.26%		4,231	3,698	-12.6%	0.55	0.65	
GF	1,074,308	1,940		-16.15%	-4.40%		35,322	31,207	-11.6%	0.46	0.61	
GGA	4,282,371	10,990										
China	77,220	109		0.00%	0.00%		373	373	0.0%	3.89	0.98	
Albion	1,309,329	3,862		-9.29%	-12.91%		9,360	8,330	-11.0%	1.13	1.09	
Poland	31,399			0.00%			107	107	0.0%	0.66	4.14	
Corp	**34,291,407**	**52,201**	**20,966**	**-16.64%**	**-6.19%**	**16.41%**	214,016	190,169	-11.1%	**0.94**	**1.00**	

3rd QTR Score Card

Site	Energy Consumption						Energy Usage in MMBtu			Energy Scorecard 3rd QTR 2008		
	Actual			Actual Vs Adjusted Budget (%)						MBTU/$ sales		Rating
	Elect (kWh)	NG (MCF)	Steam (1000 lbs)	Elect	NG	Steam	Adjusted Usage	Actual Usage	% Reduction	2008	2007	
DGA	36,648,783	26,930	34,431	-4.54%	5.19%	28.87%	183,319	186,408	1.7%	1.06	0.71	
DF	6,037,388	20,086	22,954	-5.76%	-13.47%	36.75%	61,859	63,640	2.9%	3.89	2.78	
MSP	7,110,384	92		-16.69%	-37.26%		29,267	24,353	-16.8%	1.12	1.38	
Oxford Forge	1,539,550	2,429						7,682				
3R	12,415,654	32,351		-16.98%	-12.94%		88,184	74,713	-15.3%	1.06	0.86	
TF	13,005,397	12,165		-9.47%	-39.46%		69,109	56,539	-18.2%	1.89	2.35	
CKT	2,514,179	3,967		-18.59%	3.78%		14,359	12,545	-12.6%	4.13	3.25	
Malvern	3,284,688	3,303		-33.81%	-6.33%		20,459	14,510	-29.1%	1.23	1.11	
Minerva	4,723,200	3,865		-11.16%	-5.03%		22,209	19,981	-10.0%	1.35	1.27	
Salem	1,643,749	2,777		-13.53%	-26.46%		10,262	8,386	-18.3%	1.40	1.84	
Brazil	2,988,866	2,196		-8.73%	-8.18%		13,565	12,394	-8.6%	0.57	0.61	
GF	3,061,077	3,870		-18.17%	-13.75%		101,071	84,430	-16.5%	0.46	0.60	
GGA	11,812,773	29,810										
China	494,640	1,919		1.08%	-7.32%		3,740	3,607	-3.6%	4.25	1.84	
Albion	3,733,625	9,763		-9.37%	-26.16%		27,278	22,502	-17.5%	0.92	1.07	
Poland	80,034			0.00%			273	273	0.0%	1.47	4.79	
Corp	**109,554,437**	**153,094**	**57,386**	**-11.64%**	**-14.06%**	**31.91%**	644,681	584,280	**-9.4%**	**1.01**	**0.94**	

September Score Card - Non Production Facilities

Site	Energy Consumption							Energy Scorecard September 2008		
	Sep-07		Sep-08		Energy Usage in MMBtu			MBTU/ft^2		Rating
	Elect (kWh)	NG (MCF)	Elect (kWh)	NG (MCF)	2007	2008	% Delta	2007	2008	
WHQ	430,707	86	416,579	74	1,556	1,495	-3.9%	6.16	5.92	
Training Center	11,886	0	9,094	0	41	31	-22.5%	4.77	3.70	
Quality Center	37,589	18	27,419	3	146	96	-34.3%	6.09	4.00	
PDC	28,495		37,589		97	128	31.9%	8.10	10.69	
Tech Center	777,335	0	822,418	19	2,652	2,825	6.5%	34.94	37.23	

3rd QTR Score Card - Non Production Facilities

Site	Energy Consumption							Energy Scorecard 3rd QTR 2008		
	3rd QTR 2007		3rd QTR 2008		Energy Usage in MMBtu			MBTU/ft^2		Rating
	Elect (kWh)	NG (MCF)	Elect (kWh)	NG (MCF)	2007	2008	% Delta	2007	2008	
WHQ	1,374,153	224	1,352,709	208	4,913	4,823	-1.8%	19.47	19.12	
Training Center	37,366	2	30,750	2	129	107	-17.4%	15.23	12.59	
Quality Center	116,798	18	85,407	3	417	294	-29.4%	17.35	12.25	
PDC	84,789		114,383		289	390	34.9%	24.11	32.52	
Tech Center	2,262,152	1	2,643,237	58	7,719	9,077	17.6%	101.71	119.59	

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Attachment # 4

2008 July 4th Shutdown Report

Bitar, Afif

From: Bitar, Afif

Sent: Friday, July 11, 2008 11:32 AM

To: Vanderhoof, Daniel; Moehlau, Curt; Heslin, Mark; MacDonald, Dave (Cheektowaga); Kenyon, Todd; Griffin, Peter; Romano, Kevin; Burke, Thomas (Colfor); Wyrosdick, Mike; Fry, Tom; Maxwell Tim; Trathen Michael J.; Theis, Paul; Sheldon, Blayne; Guaresimo, David; Taveira, Ricardo; Reinhard Lance; Kriger, Jair; Smith, Kevin; Morales, Daniel; Rodriguez, Nereo; Joseph, Donald; Fang, Kevin; Wang, XiaoDong; Moriguchi, Inacio; Pannucci, Michael Jr.; Andreski, Dennis; Forshee, Kim; Figielski, Michal; Coetzee, Mike; Yezback, Gregory; Campbell, James; Catoni, Matthew; Isambert, Ovelio; Applin, Lawrence; Liburdi, Samuel; Moreno, Mark

Cc: Dauch, Richard E.; Dauch, David C.; Rahangdale, Yogen; Bellanti, John; Culton David; Sofia, John; Howell, Curt; Kendrick, Robin; Willemse, Norman; Monich, Al

Subject: 2008 July 4th Shutdown Curtailment Report

Following AAM's drive for continuous improvement and energy cost reduction, the **Corporate Energy Team** has evaluated the energy performance of the facilities observing the 2008 July 4th weekend shutdown.

It is encouraging seeing that most locations showed their commitment to the energy curtailment program. Overall **AAM exceeded the 25% goal, achieving 23%**. This result shows the extra effort that some facilities have taken to go beyond the goal.

GGA took a step further by tracking the plant's energy usage daily to assure that load curtailment is effective. **This approach led to only 14.7% energy used** compared to a typical production period. The fact this site is 1.5 million square feet makes **the accomplishment** even more **impressive**. We encourage that all plants follow GGA steps in order to adjust curtailment practices ASAP and minimize lost opportunities.

Had all facilities achieved the 25% goal, an additional saving of $12,295 could have been achieved during the evaluation period.

The list below describes some of the **great performers** that were observed during the 2008 July 4th shutdown:

- **Guanajuato** site had excellent curtailment during the entire shutdown week.
- **Three Rivers'** chillers were off during the shutdown period. There was an overall 10% curtailment improvement from the 2007 July shutdown.
- **DGA Plant 2, Plant 8 and CWP** performed well by reducing energy usage and the three 1150 Ton chillers were off during the three day weekend.
- **BGA** proved its commitment to the energy curtailment program, reducing its energy usage to as low as 750 kW demand.

Below are some **opportunities** to be pursued in future shutdowns:

- **Cheektowaga** presented excessive Compressed air (CA) during the shutdown. Hence, this plant should look into reducing the pressure to the required demand during the shutdown in order to use the smaller compressor. It also appears evident excessive air conditioning units were running during the shutdown period.
- Even though **Tonawanda Forge** exceeded the goal, its CA load was found high in respect with its total load, about 38% of it, and previous shutdowns performances. When comparing the CA load with the 2007 July shutdown total load, it was found that it represents about 67% of the entire facility load. Therefore, the plant is encouraged to pay close attention to the CA system in order to adjust it effectively in respect with the CA demand during the shutdown.
- In **EDC**, two of the 1750 HP air compressors were running during the shutdown to maintain the demand. Since a

specific pressure set point is not needed due to the furnaces not running, a lower system demand pressure could be used during the shutdown. By repairing existing leaks in the system, this lower system pressure can be provided by one 1750 HP air compressor.

- Although **Oxford Forge** exceeded the goal, it needs to be more aggressive and follows MSP practices for better results. MSP performance has been as good as 4% of typical usage in previous shutdowns.

- **DGA 7** should look into the over use of supply/exhaust fans. Considering the construction of Plant 7 is similar to Plants 4&5, the 16 Percent Production achieved rating earned by Plants 4&5 should be attainable.

- **Minerva** should look into running only the smaller compressor and pay close attention to the over use of supply/exhaust fans and pumps during the shutdown.

Since some of our international sites do not observe the July 4th holiday, Albion, Brazil, Changshu and Olawa, were not included in this report. However, all of the sites' curtailment efforts will be observed on upcoming weekends and we will track usage based on production schedules. The **Corporate Energy Team** will be performing an energy analysis for those locations in the next two month to evaluate usage during non production hours.

During non production hours, each facility should make every effort to reduce energy to lowest possible and keep the plant in safe/stable mode. However, since EDC never completely shuts down and the WHQ is a non-production facility, different Percent Production Achieved Ratings are necessary. Without production and furnaces running, the target rating for EDC is figured to be 35%. This necessitates only one air compressor and close attention to the operation of the salvage water pumps. **The Corporate Energy Team** will be looking at providing a dedicated small air compressor that will efficiently generate the required pressure for furnaces in idle mode during shutdowns. The target rating for WHQ is 40%.

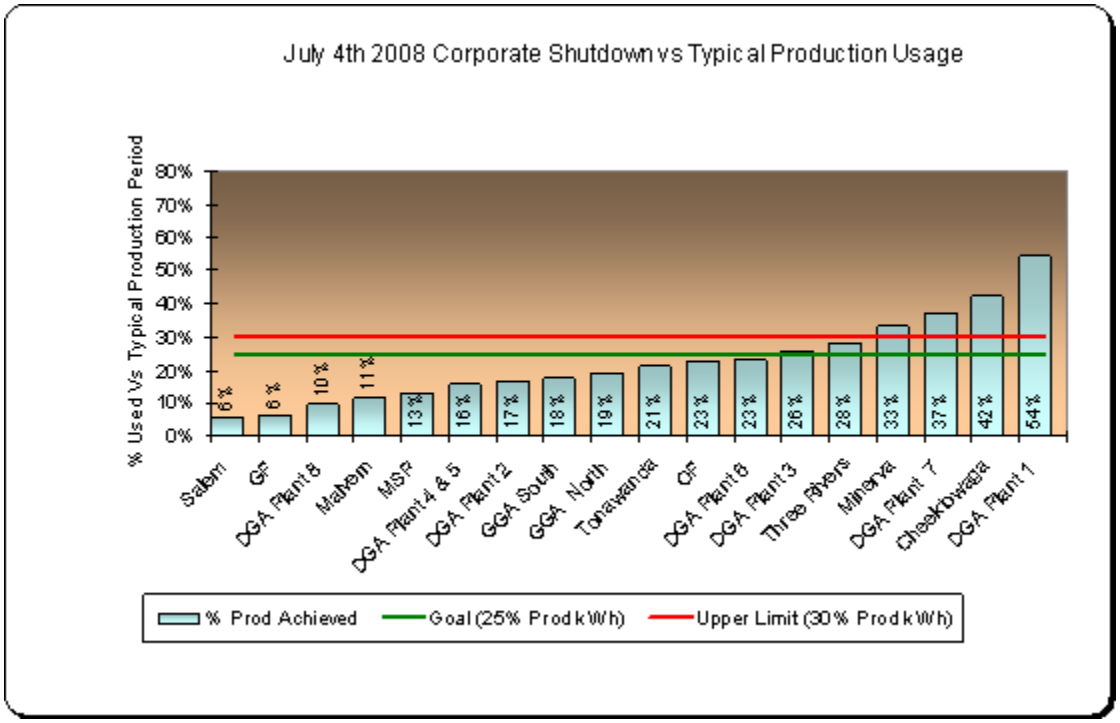
The table below compares the July 2007 and 2008 shutdown results. The following charts rank all plants accordingly to their energy performance during the shutdown, and compare the HVAC and compressed air load during the shutdown in respect with their electrical usage during typical production.

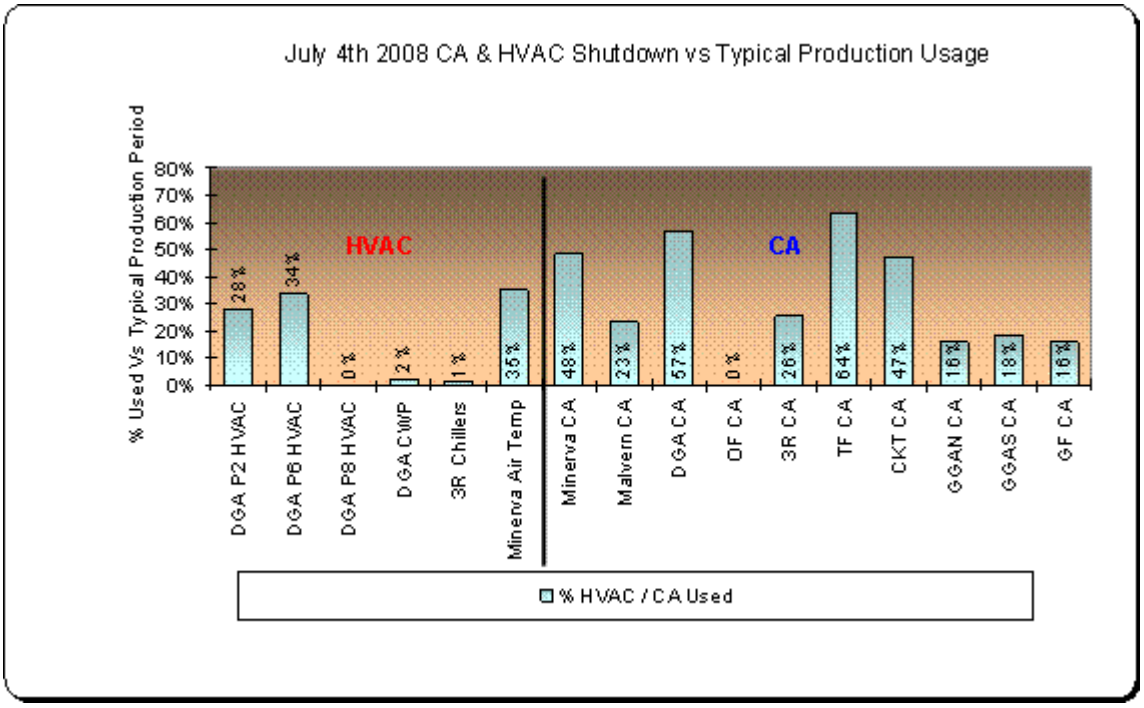
Proactive Measure for Natural Gas (NG)

All facilities should be proactive in attempts at looking into methods to minimize natural gas usage for production and heating this year. Natural Gas prices have escalated to more than $12.50 / MCF. With the current uncertainty with oil prices and instability in the region, some analysts do not expect natural gas prices to revert back to AAM's previous level of $8.50 - $9.50 / MCF.

Based on 2007 AAM NG usage, it is **expected to pay an additional $3.8M** due to price increase **with no additional revenue which will impact the bottom line**. A proactive approach needs to be seriously taken in order to avoid eroding the overall financial results.

July 4th 2008 Corporate Energy Curtailment Results		Shutdown Usage		Typical Production 8 Hour Shift		% Prod Achieved					Shutdown Savings If 25% Attained	Rating
Site	Shutdown Period	kWh	kWD	kWh	kWD	2008	Shut 2007 kWd	Typ Prod 2007 kWd	2007	Delta		
WHQ	July 4 12AM-July 7 12AM	27,303	379	7,983	998	38%	427	1,168	37%	-1%		
DGA Plant 1	July 4 12AM-July 7 12AM	109,399	1,519	22,407	2,801	54%	1,293	3,038	43%	-12%	$4,129	
DGA Plant 2	July 4 12AM - July 5 12AM	31,966	1,332	63,731	7,966	17%	1,792	9,562	19%	2%		
DGA Plant 3	July 4 12AM - July 7 12AM	56,511	785	24,569	3,071	26%	1,250	3,408	37%	11%	$86	
DGA Plant 6	July 4 12AM-July 7 12AM	53,554	744	25,896	3,237	23%	1,008	3,876	26%	3%		
DGA Plant 7	July 4 12AM - July 7 12AM	23,754	330	7,051	881	37%					$552	
DGA Plant 8	July 4 12AM-July 7 12AM	9,332	130	10,770	1,346	10%	279	1,455	19%	10%		
DGA Plant 4 & 5	July 4 12AM-July 7 12AM	40,864	568	28,829	3,604	16%						
EDC	July 4 12AM-July 7 12AM	189,785	2,636	35,813	4,477	59%	2,533	4,405	57%	-1%	$5,388	
DGA CWP	July 4 12AM-July 7 12AM	2,652	37	13,679	1,710	2%	594	2,430	24%	22%		
MSP	July 4 12AM-July 5 12AM	13,049	544	33,815	4,227	13%			4%	-9%		
OF	July 4 12AM-July 7 12AM	9,834	137	4,820	603	23%						
Three Rivers	July 4 12AM-July 7 12AM	172,304	2,393	67,895	8,487	28%			38%	10%	$977	
Tonawanda	July 5 12AM-July 6 12AM	52,577	2,191	82,355	10,294	21%	1,256	12,378	10%	-11%		
Cheektowaga	July 4 12AM-July 5 12AM	17,262	719	13,664	1,708	42%			37%	-5%	$491	
Malvern	June29 12AM-July 7 12AM	93,279	486	34,173	4,272	11%						
Minerva	July 4 12AM - July 6 12AM	45,136	940	22,631	2,829	33%			40%	7%	$671	
Salem	June29 12AM-July 7 12AM	17,509	91	13,079	1,635	6%			7%	1%		
GGA North	June 30 12AM -July 5 12AM	141,510	1,179	50,100	6,263	19%						
GGA South	June 30 12AM -July 5 12AM	46,197	385	17,426	2,178	18%						
GF	June 30 12AM -July 5 12AM	30,277	252	31,226	3,903	6%						
Corporate Totals			17,776		76,489	23%					$12,295	





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Attachment # 5

Christmas Curtailment Memo

Bitar, Afif

From: Bitar, Afif

Sent: Friday, December 14, 2007 1:05 PM

To: Weber, Norm; Pannucci, Michael Jr.; Vanderhoof, Daniel; Elleman, Christopher; Yezback, Gregory; Sams, Jay; Burke, Thomas (Colfor); Wyrosdick, Mike; Romano, Kevin; Fry, Tom; North, Michael; Theis, Paul; Griffin, Peter; Moehlau, Curt; Kenyon, Todd; MacDonald, Dave (Cheektowaga); Smith, Bill (CGA); Smith, Kevin; Reinhard Lance; Martin, Jose Luis; Fang, Kevin; Wang, Peter; Orozco, Hector; Morales, Daniel; Flores, Federico; Felix, Alfonso; Taveira, Ricardo; Kerr, Martin; Forshee, Kim; Moriguchi, Inacio; Kriger, Jair; GuillenUranga Fernando; Isambert, Ovelio; Catoni, Matthew; Trathen Michael J.; Heslin, Mark; Reinhard Lance

Cc: Bellanti, John; Conroy, Joseph; Willemse, Norman; Dauch, David C.; Rahangdale, Yogen; Howell, Curt; Krucki Chris; Maxwell Tim; Sibley, Dave

Subject: Christmas Curtailment Memo

Importance: High

With the holiday shutdown right around the corner, the Corporate Energy Team would like to remind everyone about the benefit of energy efficiency to AAM. Especially with seemingly perpetual increases in energy costs, production volumes, several opportunities for financial savings exist during the upcoming 10-day shutdown period.

As in the past, energy will be tracked during a typical 1st shift from this December. The average hourly kW for this 8-hour period will then be compared to the average hourly kW of the shutdown period. Production/maintenance from the O.T. schedule will also be considered. Generally, the goal consists of consuming 25% or less energy usage during the shutdown when compared to a typical production 1st shift.

Below are some energy curtailment rules of thumb at all times; especially during the holiday shutdown:

- **Lighting**
  - Lighting should only be on in areas of production or maintenance
  - Outside lighting should only be on during dark hours
  - Office lighting should only be on where necessary
- **Air Compressors**
  - Only air compressors in use are to be turned on
  - Run the compressor that will best fit the shutdown demand
  - Air compressors are not to be used for cleaning
- **HVAC**
  - Reduce the heating thermostat to 60° making sure we do not cause pipe freeze
  - Shut all doors to prevent facility heat loss
- **Processes**
  - Where feasible, turn off all
    - Exhaust Fans
    - Pumps
    - Blowers
    - Conveyors
    - Unused Equipment
    - Boilers
    - Heat Treat Furnaces
    - Hydraulic pumps

In short, only use lighting, air compressors, HVAC, and process equipment where necessary. Keeping these ideas in mind will enable us to improve further on the collectively successful Thanksgiving shutdown.

Thanks for your time and cooperation, Merry Christmas and have a Safe Holiday

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Attachment # 6

AAM Energy Management Handbook

ENERGY STAR PARTNER

AMERICAN AXLE & MANUFACTURING

ENERGY MANAGEMENT HANDBOOK

AAM Corporate Energy Team

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Preface

The "Energy Management Handbook" is intended to assist in guiding the effective execution of an energy management program at American Axle & Manufacturing plants. The goal is to reduce the amount of energy being used. The costs saved will be allocated towards plant production.

This handbook will be used primarily by the Energy Champion and Energy Committee at each plant, but can also be used by other plant personnel as a reference for energy related issues. The "Energy Management Handbook" is to be considered as neither an academic text book nor as a substitute for appropriate training, but solely as a general guide to key elements in an energy management program. It is the readers' responsibility to seek outside references if further explanation on a topic is required.

For any comments regarding this handbook, please contact:

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AAM Energy Policy

Commitment
Escalating and volatile energy costs compromise American Axle & Manufacturing profitability. Therefore, as part of its strategy for profit, AAM is committed to serious and responsible energy management. This requires using and purchasing energy in the most cost-effective ways possible within safe practices and environmental standards.

Objective
AAM will continuously improve its energy performance where possible. It will carry out this policy without compromising safety, reliability, and environmental standards by establishing and implementing an effective "Energy Awareness and Management Program."

Goals
- Incorporate energy efficiency in daily activities to maximize the possibility of identifying energy saving opportunities.
- Efficiently and practically use energy throughout the company's production and non-production facilities.
- Evaluate the plants' current equipment to identify energy saving opportunities.
- Incorporate energy efficiency into the selection of new equipment for production and non-production facilities.
- Purchase energy from suppliers that best fit AAM's cost and quality needs.
- Reduce pollution; particularly CO2 emissions indirectly caused by AAM's energy use.

Applicability
This policy shall apply to all worldwide American Axle & Manufacturing facilities, subsidiaries, business units, and associates.

Administration
The AAM Energy Team will be responsible for administrating this policy, as well as evaluating and updating the policy to reflect changing needs and priorities.

Richard E. Dauch
Chairman of the Board & CEO

Chapter 1 – Introduction

Plant Energy – An Overview

Energy Allocation

It is useful to know where energy is being used in the plant so that one can target the largest users for energy savings. Fig.1 shows the approximate energy distribution of American Axle Plants. Exact percentages at a given time depend on plant design, production levels, and weather conditions. In any case, this information can be used to help each department track their energy management performance.

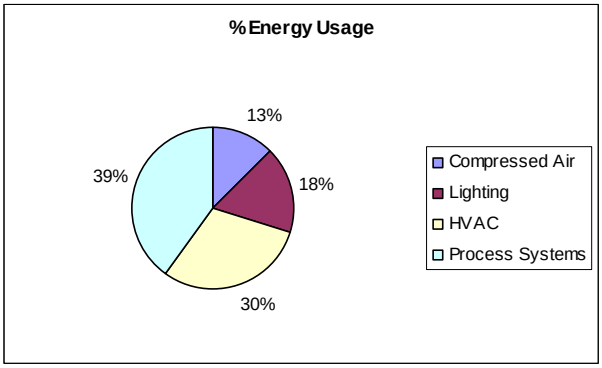


Fig – 1

Energy Influencing Factors

To some extent, weather plays a determining role in plant energy use. The following is a list of weather related dependencies:

1. Cooling Degree Days (CDD): The measurement of cooling energy required to keep the facility at a comfortable temperature. It records the average number of days the weather is above 65°F during a given period of time. CDD determines the chiller and air conditioner load for plants with air conditioning or a tempered air system. The primary impact will be an increase in electrical usage during the summer months of June through September.
2. Heating Degree Days (HDD): The measurement of heating energy required to keep the facility at a comfortable temperature. It records the average number of days the weather is below 65°F during a given period of time. Heat is typically provided by natural gas or steam. The lower the temperature, the more fuel required to heat the plant. Fuel consumption will depend on temperatures throughout the year.
3. Production: An increase in production will result in an increase in energy usage. Weather plays an impacting role on energy used for production. More energy may be required to operate a facility during the winter, or more air conditioning may be required to remove heat generated from electrical equipment as production increases during the summer.

Other plant energy usage factors include *operating modes*. These modes may not necessarily be well-defined, and transitions from one mode to another may take several hours as equipment is started and shut down. However, these modes may also help determine appropriate measures in energy reduction to help save energy. The following is a list of typical operating modes:

1. Plant Shutdown: Plant shutdowns represent non-production periods used to control production level and to facilitate maintenance and model changes. Plant shutdowns can come in several forms. Please refer to *Chapter 5: Curtailment Plan* for further explanation on the various types of shutdowns. Usually, during longer shutdown periods, more equipment can be shutdown leading to greater energy reduction. However, even on extended shutdown periods, it will be necessary to run some equipment to support maintenance or testing. At times, setting equipment in an idle mode may be more efficient since shutting down and restarting a piece of equipment may require a substantial amount of energy. Also, certain settings that may not want to be lost or reconfigured will be saved during an idle mode.
2. Non-Production Hours: Non-production hours are when a plant s ready for operation, but production is not in progress. This refers to the plant condition immediately before and after production starts and ends, respectively. Studying this condition can help sort out support equipment loads from those that actually use added energy to produce a part. This condition may also be observed during break and lunch periods.
3. Plant Operating: This is where the plant is in production mode. Some plants may have various levels of production.

How We Can Make a Difference

Several points of opportunities arise during the life cycle of a plant where the energy use of the plant can be impacted. The following is a list of areas where we can make this impact:

- Design: The phase where the plant is being designed. It is here where the most dramatic energy saving features can be incorporated in the most cost effective manner. Adding energy efficient equipment (i.e. motors, insulation, chillers, etc…) during the design phase is more cost effective than worrying about the incremental full replacement cost in the future. In cases where initial cost is a deciding factor, it is recommended to design the system to allow other energy efficient features to be added later.
- Startup: This is the phase where energy saving features incorporated in the plant design is tested and applied. During this phase it is important for plant personnel to understand and have training on the operation of new energy saving features to optimize performance. Designers and major equipment suppliers are to gather expected energy use for building environmental control systems and take actual measurements to confirm equipment performance. If equipment does not perform as expected, the designers and suppliers should be contacted to resolve these issues.
- Maintenance: Neglecting maintenance will decrease the efficiency of energy conservation features in the plant, resulting in increased energy costs. This usually goes unnoticed, and over time can easily increase energy usage and cost by 10-20%. Corrective and preventive maintenance can be applied to maximize

plant efficiency. Although maintenance costs money in terms of people and material, savings may be more significant in the long run.

- Operations: This broad topic includes the operation of air compressors, boilers, chillers, etc., and almost anything else that can impact energy use. This can range from the implementation of an Energy Management System (EMS), to the operation of truck doors, and to the execution of curtailment plans. None of these activities will change the design or structure of the plant, but how it is used. These actions can have a 10-30% impact on plant energy use. Improvements of operating practices can lead to savings with minimum costs in most areas.
- Upgrades: Upgrades are changes to the plant design; typically to implement a model change, install more efficient equipment, or implement government-mandated changes. They also allow installation of energy saving features that would not be cost effective alone as upgrades, but will when combined with other changes. Upgrades allow the installation of new technology that was not available when the plant was initially built. It also allows the installation of features that were not obvious during the initial design and construction of the plant, but are effective based on experience during plant operation.

Energy Champion

In general, the plant Energy Champion will be a senior member of the Plant Facilities Engineering Staff. It is their responsibility to pull together the various aspects of the energy management program described in this handbook. The Energy Champion should have a technical background in energy management and it is highly recommended that they become certified by the Association of Energy Engineers as a Certified Energy Manager. The Energy Champion is responsible for the following:

- Serves as a chairman of the Energy Management Team. Although many involved in the program may not report to them directly, it is their responsibility to work with staff managers in other departments to implement the overall energy management program.
- Serves as a source of information on energy management to plant personnel. They assist others in obtaining energy management information and provide information and education to all plant personnel.
- Reports on energy use against goals to both plant personnel and management. This includes, but not limited to, developing energy management goals and performance assessment.

Energy Management Team

The Energy Management Team is a key communicator between all organizational levels of plant management. The team must have a representative from each key plant department to be effective. Its main purpose is to coordinate energy management activities between departments and facilitate energy management communication across the plant

organization. Although the plant's Energy Champion is a key focus for energy management, they cannot be effective without the Energy Management Team.

Chapter 2 – Energy Tracking and Forecasting

This section discusses how to track energy usage and forecast cost projections for future years. Furthermore, it will introduce methods and techniques to determine these costs and assist in developing commodity projections, budget projections, and setting goals for the plant. Three steps should be followed to ensure a successful projection:

1. Collecting Data
2. Forecasting
3. Tracking

Collecting Data

Before setting goals, one must have projections for utility usage. Projections can be difficult to determine due to changing factors, such as the weather and production, thus making it difficult to meet goals. Accurate projections can be achieved by looking at trends from historical data. The following sections discuss this in further detail:

Historical Data

In order to determine key dependencies and trends, it is required to obtain historical data from the past several years. The most important of this data is collected within the previous 12 months; especially when trying to determine a short term forecast. When determining long-term forecasts, it is recommended to obtain at least three years of utility and climatologically data. For more precise readings, a collection of daily data is highly recommended to point out major changes in production operations such as shifts, expansions, schedules, etc…

Water, natural gas, and electrical usage data is readily available through utility bills. Usually, production data can be found from PC reports. It would also be helpful to collect data on cooling degree days and heating degree days for the months utility data was obtained. Other weather related data can be obtained from local or national weather services.

The following is necessary to develop a model to forecast utility costs:

- Utility Usage – Four major types of utility data required.
  - Electrical: kWh per month and peak kW demand.
  - Gas: cubic feet per month.
  - Water: cubic feet per month.
  - Steam: 1000 lbs per month
- Monthly Utility Costs.
- Days worked per month.

- Plant Production level per month (Production data such as sales).
- Historical HDD and CDD for time period being studied.
- Plant change history (building expansions, equipment changes, etc…)

Forecasting

Statistical models such as multiple-linear regression, and specially-developed 2, 3, 4 and 5-parameter change-point regression models are used to quantify relationships between building energy use, weather and other energy drivers such as production. A 3-Parameter model was used to estimate the energy usage with changing outside air temperature, Toa (F), and production, sales in US$. The model comprises four regression coefficients that are combined with the weather and production variables in a single equation. The equations for modeling electrical and natural gas usage are presented below:

Elect = Ycp + RS * (Toa - Xcp) + X2 * Sales If (Toa - Xcp) < 0, then (Toa - Xcp) = 0

NG = Ycp + LS * (Xcp - Toa) + X2 * Sales If (Xcp - Toa) < 0, then (Xcp - Toa) = 0

In these equations Ycp, Xcp, X2, RS, and LS are the regression coefficients while Toa and Sales are the weather and production variables, respectively.

- Toa indicates the actual monthly average outdoor air temperature in the facility region.
- Ycp is the model coefficient that represents the baseline energy usage (independent energy usage)
- Xcp is the model coefficient that represents the temperature above or below where space cooling and space heating start (weather dependent usage).
- RS indicates the change in energy usage in respect with average outdoor air temperature after the space cooling starts (Right Slope – Weather dependent energy usage)
- LS is the model coefficient that represents the change in energy usage in respect with the average outdoor air temperature after the space heating starts (Left Slope – weather dependent energy usage)
- X2 represents the impact of production changes over the plants' energy consumption (Production dependent energy usage)

Statistical figures such as the Coefficient of Multiple Determination, R2 value, and the Coefficient of Variation of the Root Mean Square Error, CV-RMSE, were used to evaluate the accuracy of the models. The R2 value indicates how well the model describes the data. The closer it is to 1 the better the model describes the data. Any value above 0.75 is deemed acceptable by the International Measurement & Verification Protocol (IMVP)

practices. The CV-RSME is an indication of deviation and the closer it is to 0%, the better the model fits the data.

Once the models are developed, they can be used to project energy usage given actual sales and outdoor air temp (adjusted budget). Projected and actual energy usage is compared to evaluate the plants' energy performance. The accuracy of the models is taken into account when evaluating the plants.

Creating a Model

The following procedure describes how to create a regression model to project energy usage with changing production and sales conditions.

- Download one year of weather data from local or national weather services
- Calculate one year of monthly average outdoor air temperature
- Gather one year of monthly production data; one year of monthly sales data in AAM's case
- Collect one year of monthly energy usage data (Electrical, Natural Gas, Steam)
- Calculate monthly energy usage and production (sales) per day to normalize for different billing periods
- Drive the production (sales) and temperature data with any statistical software capable of creating 3-Parameter regression models for space heating and cooling

Tracking

Once the models are developed, one must track projected values with actual usage in order to evaluate the plants' energy performance and models' accuracy. Valuable information gathered during the tracking analysis can be used for setting goals and projecting upcoming energy budgets.

In addition, one must track utility invoices to monitor energy costs and other energy-related factors such as contract conditions, penalties, etc. During the invoice tracking analysis, attention should be paid to the following:

- Estimated readings must be in accordance with actual readings.
- Late fees
- Low power factor and power factor penalty
- Peak Demand
- NG storage where available.
- Fraction of Utility Cost over Sales (% Sales)
- Energy Intensity (MBtu / $ Sales)

- Exchange currency for International sites

Monthly and quarterly reports distributed to all plant managers compare each plant's energy performance from the current period with the same period of the previous year. Every anomaly found during the invoice tracking analysis should be reported immediately to the **AAM Corporate Energy Team**.

Each month a scorecard measures electrical, natural gas, and steam performance for each AAM location. Forecasted usage, based on the previous year, production (sales) and weather (for some locations) are compared with actual usage. Since the corporate goal is to reduce energy by 5% from the expected usage, then a green rating is given for each location matching or surpassing this goal. A yellow rating represents a location using less energy than forecasted, but by less than 5%. When neither of these standards is obtained, the rating will be red. Sometimes "half" ratings, such as green-yellow and yellow-red, represent a location's energy performance during a given month. This indicates a facility's energy performance falls within the above scenarios, but attention should be directed toward a certain issue. For example, a facility reducing overall by 1%, but increasing natural gas usage by 10% could yield a yellow-red rating.

Chapter 3 – Awareness Programs

Communication is a crucial aspect of a good energy management program. An effective awareness program can accomplish several objectives:

- Provide general energy information and education.
- Provide employees with home energy savings ideas which can be carried on through the work environment.
- Solicit support for energy savings policies.
- Solicit employee energy saving ideas.
- Recognize employees or teams that are supporting energy savings.

Communication tools vary from plant to plant. If possible, use existing tools rather than creating new ones, as the existing tools may already have an interested audience. Several forms of communications will be necessary to reach the entire AAM population.

A good source of ideas, advice, and creative talent is the American Axle Manufacturing Energy committee. It is advised to work with the committee to develop a communications plan that effectively conveys energy-related messages with their team members. Once the new policies have been applied, it can be observed how effectively they are being implemented by on-site monitoring.

It is useful to obtain feedback on the effectiveness of various communications vehicles. When new policies are enacted, one can observe how effectively they are being carried out by on-site monitoring. For example, one might do an after hours walk through to check if lights, computers, etc. are being shut off during unoccupied periods. Energy Committee members should be involved in soliciting feedback through proper communications.

Communications Tools

Newsletters

AAM publishes the company Energy Newsletter. The following are a few topics generally covered by the newsletter:

- Information on American Axle Manufacturing energy bills.
- How much energy is used in various parts of the plant.
- Changes associated with different seasons such as startup of heating units or air conditioning and energy savings tips.
- Energy savings policies – turning off lights and equipment on back shift, turning off lights in unoccupied spaces, shutdown computers and office equipment during off hours, etc.

- Home energy savings tips – thermostat settings, insulation, storm doors and windows, etc.
- Expected building temperature variations and personal preferences, and dressing for personal comfort to maximize worker safety and efficiency.
- Energy saving initiatives such as equipment retrofits and practices.
- Recognition of people who have contributed to energy saving efforts.
- American Axle Manufacturing Energy Committee including membership and activities.
- Solicit suggestions for energy savings ideas.

Articles are written in an interesting and informative manner, keeping in mind that they will be read by a wide variety of people with different backgrounds, education, and knowledge. Creative article titles and pictures are used to help catch one's eye and get people to read the newsletter.

Cable Station

An American Axle Manufacturing cable station would be a good tool to spread the energy efficiency programs throughout the plant. The information outlined for newsletters is appropriate material for this communications tool.

Bulletin Boards

Bulletin boards will be placed in high traffic areas, such as entrance corridors or areas adjacent to plant entrances, targeting as many people as possible.

Bulletin boards provide an opportunity to expand on the themes listed in the American Axle Manufacturing Newsletters and the Energy Policy. This helps reinforce these messages and provides more explanatory material on a particular issue such as graphs, pictures, and tables on a particular issue. The following are a few suggestions for bulletin board materials:

- Obtain dedicated bulletin board space that can be used for energy related messages.
- Use large text font so the message is easy to read.
- Title sections with bold headlines or graphics that catch people's attention.
- Label your bulletin board area with a banner at the top highlighting the message content. Use color and graphics to catch people's attention.
- Rotate the materials on the bulletin board periodically; otherwise the content will become stale causing people to ignore the bulletin board.

- Regularly update the status of energy use in the plant. For example, post summary pages from the monthly energy report, graphs of energy usage, and year-to-date costs of utilities.

E-Mail

E-mail can be an effective tool for communications. The following are possible target populations and messages:

Energy Committee Members

- Energy usage updates – over holidays, weekends, shutdowns, etc.
- Reminders of energy reduction actions in support of a shutdown.

American Axle Manufacturing Management

- Periodic updates on American Axle Manufacturing energy performance, especially developing good or bad trends.
- As a tool to reinforce need for support of specific energy reduction policies.

A few suggestions for e-mail messages:

- Keep them short and to the point.
- Put the message in the title line, sometimes that is all that will be read.
- Send them on irregular intervals when you want to convey a message.

Other Communication Tools

Meetings and other communications tools can help get interest in the American Axle Manufacturing Energy initiatives. The following are a few ideas:

- Energy Reduction Ideas Contest: Hold a contest to solicit energy reduction ideas. Consider awarding prizes such as several gift certificates for $50 or $25 to a local department store. Award some prizes at random and some for the best ideas. This will encourage broad participation. Use the Energy Committee members as judges to help screen the entries for the best ideas that can be implemented. Be sure the contest is well publicized by advertising to encourage participation.
- Posters: There are numerous sources of posters that deal with energy conservation issues. Enter the words “Energy Conservation Posters” on any of the Internet search engines to look for available materials. Plants may also have graphic capabilities that will allow you to create your own posters.
- Energy Conservation Reminder Signs: The most common version of this is the sign located near the light switch in various rooms that says “Please turn off the lights when you leave this room!” These signs are often small, dull, and ignored. Consider spicing them up with colored pictures and humor. Similar signs may be

placed in conference rooms, filter houses, storage rooms, or any other place where the lights or other equipment could be turned off when not in use.

Chapter 4 – Energy Audits

Process Overview

A successful energy audit is a several step process in the order as listed below:

Preparation Phase

The primary purpose of this phase is to perform a detailed analysis of what is happening in the facility before a walk-through. This helps in maintaining better records and implementing a more efficient energy audit. The following ways can help ensure this:

- Data Collecting: Before walking through the facility, one should gather the "real" costs of equipment being used and not the blended cost in order to prevent over/under estimating in the final analysis. One can do this by breaking down utilities in a table format with costs and savings for each category.
- Utility Analysis: Based on the data collected from above, one can do a utility analysis to determine the energy demand and energy use. One crucial aspect to this is determining the load factor. Usually, a higher load factor means higher savings and an increase in production. It is also important to do a load factor analysis during a shutdown period. An effective way to do this is to create a pie chart comparing the actual consumption during a period with the demand during that period.
- Financial Review: Although this is not technically part of the audit, it is advisable to review bills and other finances to ensure no mistakes have been made before going out to the field. Sometimes by catching these mistakes, one can save the time and cost of issuing an energy audit.

Value Mapping and Energy Audits

This phase involves a facility walk-through and review to identify current equipment that uses energy and practices involved in the operation of this equipment. Here, one should look for opportunities to save energy; which may involve several forms changing, including equipment change, plant process, or operating changes.

Planning

This phase involves the development of a detailed plan on how to carry out proposed changes, obtaining appropriate funding, developing an implementation organization, and assigning responsibilities for various tasks. Planning typically covers three main categories as follows:

1. Process Changes: These include actions such as turning off lights and exhaust fans during non-operational hours reducing compressed air pressure. These are typically the easiest and involve the highest rapid payback.

2. Maintenance: These include repairing air leaks or fixing truck doors to improve insulation.
3. Modifications: These include actions such as installing a compressor control system, an Energy Management System, or replacing lights. These are probably the most difficult to implement and might require capital funding.

Implementation

This stage involves carrying out the actions approved in the planning phase.

Follow-up Assessment

This stage is necessary to ensure that desired energy savings are being obtained. This may require checks over an extended period to be sure actions and practices are consistently being carried out.

Corrective Action

If initial plans and actions are not producing the desired energy savings, then it will be necessary to reassess why the savings are not being achieved and take corrective action.

Saving Strategies

The following is a guideline for effective energy audits in manufacturing facilities.

- Shutting Off Motors: If several pumps are working in parallel and the pumping capability is not needed, shut enough pumps off so the other pumps are fully loaded. This concept can be applied to other equipment, such as air compressors, fans, chillers, etc… The most efficient motors are those running at loads over 50%. The efficiency of smaller motors under 100 hp drops off faster than larger motors. In short, it is more efficient to run one motor at 80% load than two at 40% load.
- Reduce "Downstream Loads": Motors often drive air and fluid through ventilation ducts or pipes. Reducing downstream load can reduce electrical load. Use larger pipes or ventilation ducts, as well as pipes and ducts with a lower friction factor. Keep pipes and ducts free of obstructions. This includes fouling of cooling water pipes and dirty air filters in ventilation ducts and air supply hoses.
- Replacement Motors: Replace old motors with new energy efficient ones if possible. Usually, the energy saved will pay for the cost of installation in a couple of years. Unfortunately, the motor will often be a standard motor in the warehouse and the replacement may take place under near emergency conditions. Typically, it is more cost effective to replace failed motors 50 hp and under and rewind motors over 50 hp. Most motors are readily available

and one should consider purchasing and installing a new energy efficient motor instead of installing the motor on the shelf and then putting the new, hopefully energy efficient, motor on the shelf. It should be noted that motor rewinds, on average, result in about a 1% reduction in motor efficiency. This is typically caused by damaging and reducing the magnetic properties of the laminates during bake out to remove the old windings and insulation by overheating the motor. A poor rewind job can result in the loss of several-percent efficiency and limiting the life of the motor. One thing to look out for in motor replacement is the impact of the pump and fan laws. Since energy efficient motors tend to run at slightly higher speeds in pump and fan applications where power goes up by the cube of the speed ratio, the power increase can be quite significant and results in cancelling any energy savings.

- Motor Belts: The majority of belt drives use V-belts, which can have a peak efficiency of 95% to 98% at the time of installation. Efficiency depends on pulley size, driven torque, under or over-belting, and V-belt design and construction. Efficiency deteriorates by as much as 5% over time if slippage occurs due to the belt not being periodically re-tensioned. Cogged belts have slots that run perpendicular to the belt's length and can be used with the same pulleys as V-belts. They run cooler, last longer, and have an efficiency that is about 2% higher than that of standard V-belts. Synchronous belts (also called timing, positive-drive, or high-torque drive belts) are toothed and require the installation of mating toothed-drive sprockets. Synchronous belts offer an efficiency of about 98% and maintain that efficiency over a wide load range. In contrast, V-belts have a sharp reduction in efficiency at high torque due to increasing slippage. Synchronous belts require less maintenance and re-tensioning, can operate in wet and oily environments, and run slip-free. Synchronous belts are noisy, unsuitable for shock loads, and transfer vibrations. Belt upgrades in automotive plants may improve efficiency by several percent for equipment such as fans, blowers, and small compressors.

- Voltage Unbalance: Motor voltage unbalance occurs when the three phase voltages vary. Different voltages can reduce the rating of a motor and also increase wasted energy. Percent voltage imbalance is defined as the maximum difference between the phase and average voltages. Voltage imbalances may occur because of bad connections or unequal loading of electrical phases. If left uncorrected, the bad connections may fail, and may cause the life of the motor to be shortened if the motor is running at a high enough load. Motor unbalance should be kept to less than 1%. Failing to do so may void the motor warranty.

- Match Motor Size to Load: When a motor is operated at a horsepower well below its rating, it is not being operated efficiently. Motor efficiency tends to be fairly linear down to about 40 or 50%. Below these levels the overall efficiency is poor and one should consider replacing the motor with another that more closely meets the load requirements. Another alternative may be to install a smaller pump or fan with a smaller motor and a capability similar to the existing

unit. The smaller unit can then be used when demand is low and one can use the larger unit when demand is higher. This type of change requires careful analysis, but may save significant amount of energy. If a motor is running above 50%, there is little point in changing the motor since larger motors tend to be slightly more efficient and one could end up with a less efficient system in doing this.

- Variable Speed Drives: One of the most significant energy saving devices is the VSD. In blower or fan and pump applications, the power required is proportional to the cube of the flow, which is proportional to the motor speed. In many pump and fan applications the amount of needed load varies considerably. This is due to variations in production, heating, or cooling demands that vary with the weather. Since induction motors produce nearly constant speed output just below synchronous speed, the flow for the driven device must be controlled by a pump discharge valve, a fan inlet, or an outlet damper. This is very inefficient and wastes a lot of energy that must be dissipated through the damper or valve in the form of throttling energy. A better way to accomplish this is to run the motor at a lower speed consistent with the instantaneous speed and power requirements as demanded by the system. The most reliable and efficient method of accomplishing this is to use a variable speed drive or magnetic coupling. In both cases, these devices result in a lower output speed and thus a lower power demand by the motor. The magnetic coupling is basically a magnetic clutch that varies the coupling between motor and load to provide less power to the load while letting the motor run at near synchronous speed. The variable speed drive is basically an electronic box that takes the 60 Hz power and converts it to power at a lower frequency. The minimum frequency produced is approximately 10 % of normal and thus about 10 % motor speed. Obviously, this provides a significant span of control for driving a pump or fan, but energy will be saved if these systems spend a significant amount of time operating at loads below 70%. VFDs do present some challenges and must be properly designed. They are typically found on ventilation fans, paint center process fans, and pumps with variable demand in newer installation. Though modifications may not always be possible, VFDs should be carefully considered on any new pumping fan installation.

Records

Documentations should be maintained of plant motor inventory and installation to assist in selecting the most efficient motor when a one must be replaced. Many problems can arise with motors. A good repair history log should be maintained. This will aid in identifying motors that need repeated repairs, which can be an indication of overload conditions, misalignment, or bearing wear. All these conditions can have a significant impact on motor energy usage if allowed to persist. For larger motors, a predictive maintenance program should be developed to monitor vibration, temperatures, and oil chemistry. Such a program can be an early warning of impending failure and will allow correction of the problem before

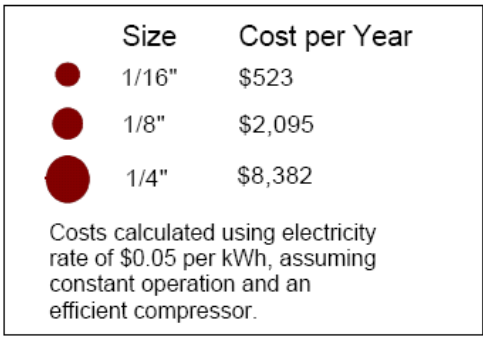
an expensive failure occurs. Many of these conditions can also be incorporated to reduce motor efficiency and energy use.

Compressed Air System

This section will concentrate on the fundamental actions that can be done to improve performance in compressive air systems.

Air Demand Management

This section discusses ways to minimize the compressed air demand placed on a plants compressor system.



Leaks - Air leaks can easily amount to 10-20% of the air demand. The cost of a given leak is determined not only by the size of the leak and system pressure, but how long it takes to identify and repair it after it occurs. The picture on the left is a quick reference to the size of leaks and their costs. The best way to identify a leak is by using an ultrasonic acoustic reader to pick up the high frequency hissing sounds associated with air leaks. A simpler method would be to apply soapy water with a paintbrush to suspected areas, however this can be time consuming and messy.

Inappropriate and Inefficient Uses of Compressed Air - Compressed air is an inefficient source of energy for many applications. The following are various applications along with their more efficient and economic solutions:

- Clean-up air is used to blow dirt out of an area – Often this does more to blow the dirt around than really clean. Instead use brooms or vacuum cleaners.
- Air blow offs to remove dust and contamination, drying, process cooling – These tasks can be better accomplished with low pressure blowers or electric fans.
- Aspirating – Aspiration can best be accomplished with a low-pressure blower.
- Vacuum generator - These are often venturi type devices that are used to hold a part steady in a jig to support the manufacturing process. Vacuum from a dedicated vacuum pump or central vacuum system. Workers should not leave parts in vacuum holding devices during plant shutdown periods in order to minimize air leakage.
- Personnel cooling - This may include running an air hose from a hose connection to a work area where the compressed air is allowed to blow on workers. An electric fan is a much more efficient way to provide cooling.

- Compressed air-operated cabinet coolers – A better method of cooling is an air-to-air heat exchanger or air conditioner.
- Air motor-driven mixer – An electric motor driven mixer is more efficient, especially if this is a continuous operation.
- Air-operated diaphragm pumps (especially if pumps are run continuously in support of the manufacturing process) - A properly controlled electric pump is more efficient.
- Idle equipment (especially if infrequently run) - Put an air-stop valve at the compressed air inlet and be sure it is shut when the equipment is not needed. This will also minimize air loss caused by leaks.
- Abandoned equipment often left connected to the air system - Disconnect air supply to equipment. This will minimize air lost through leaks in the abandoned system.
- Material moving applications (this might include movement of rivets, bolts, or other parts using compressed air) – An alternate might be to use a low pressure blower to move the parts.

NOTE: Many of these applications involve low pressure where one does not take advantage of the energy stored in the compressed air. A low pressure blower or vacuum system can do both a better and more energy efficient job.

Some of these applications, such as air use for personnel cooling or cleaning, can be identified during a plant walk-through or an air leak survey.

Even if some of these inefficient applications are impractical to change, it may be possible to minimize air use by only using them when needed. Installing an electric eye to monitor the production line and controlling a solenoid that isolates air flow when not needed can result in substantial savings.

Air Use Reduction Strategies and Actions: One can take operational actions during plant operations and shutdowns that will reduce the compressed air demand. Some of these strategies may require equipment installation or a facility modification. Most require consistent repetitive actions by plant personnel; this can be a challenge. If these actions are not taken consistently, they will not be effective and the desired savings will be lost. It is important to put systems in place ensuring consistent performance. The actions should be monitored on a spot check basis to be sure they are taking place consistently, and management should reinforce the importance of doing them regularly.

- Isolate infrequently used equipment – Many pneumatic components are only infrequently used, such as a hoists or a pneumatic pump to pump down a tank or filter housing for maintenance. To minimize air leakage, isolate these types of equipment when not in use as far upstream as possible. This will eliminate air usage due to leaks from the components in the system such as valves, filters, pressure reducers, etc.

- Isolate areas or headers during shutdown periods – When the plant is not in operation it may be possible to isolate large sections of the compressed air system, reducing air use and demand on the plant's compressors. This will allow other sections of the plant to be provided with compressed air for maintenance purposes during plant shutdown. Even if these sections are only isolated for a limited period of time, such as part of a weekend, the savings may be substantial. It may be necessary to install isolation valves in major system branches to accomplish this.
- Reduce local air pressure to lowest level needed to do the task – Compressed air systems typically provide air at a pressure of 100 to 120 psi, yet most equipment such a pneumatic tools, line stop, material handling devices, etc. use air at a reduced pressure of 15 to 30 psi. This is accomplished with the use of pressure regulators. Setting the regulated air pressure as low as possible and still reliably perform the function involved can minimize air use.
- Don't leave parts in vacuum assisted tools – Vacuum assisted tools typically use a lot of air. Production workers should be instructed not to leave parts in lifting or installation jigs during breaks or shutdown periods.
- Replace pneumatic tools with electric tools where possible – Many pneumatic tools can be replaced with electric tools. Electric tools use less energy than their pneumatic counterparts. Many new electric tools are being developed to support the industry trend in this direction.
- Reduce compressed air system operating pressure – Reducing system air pressure can be a very effective way to save money. Compressed air systems are typically designed to operate at 120 psi or more, yet most applications use air at pressures of 30 psi or less. Often the air pressure can be reduced to as low as 80 psi without impacting equipment performance. To accomplish this, the plant should lower pressure in small increments. As part of the plan, determine the equipment that requires the highest air pressure and monitor its specific performance. This needs to be carefully coordinated with plant personnel so any problems can be identified and pressure raised, if necessary, to prevent impacting production. Typically a 2 psi reduction in pressure will reduce compressor energy demand by about 1%. If specific plant systems require higher air pressure than the rest of the plant it may be possible to install larger supply piping, accumulators, or a dedicated air compressor to serve this specific need if justified by a cost benefit calculation. It may also be possible to reduce pressure further during shutdown periods. During these periods, there will be less air demand and thus less pressure drop through the air lines. Thus, it may be possible to decrease pressure several additional psi without impacting individual equipment operation for testing and maintenance.
- Air Traps and Blowoffs – Air traps remove water from compressed air lines and help maintain air quality. Unfortunately, the moist conditions they work in may cause them to fail either in the opened or closed condition. Both conditions are bad! When a trap fails in the opened state, wasted air will blow out the trap

continuously; similar to a large leak. These can be identified during air leak surveys. On the other hand, when a trap fails closed, moisture will not be removed from the compressed air and eventually cause failure of tools and equipment downstream. Sometimes when traps have failed plant personnel will open trap bypass lines around the trap and allow them to blow air continuously to remove the condensate. Occasionally, other lines or connections will be opened to remove moisture indicating the need for a trap in a particular location. Installation of a new trap is recommended for locations like this. Traps that have failed in the opened state should be repaired or replaced expeditiously. A trap installation should have a strainer installed ahead of it to keep out debris, and should be blown down periodically. A program of periodic maintenance on all traps will easily pay for itself. A trap that has failed opened can easily represent a half-inch leak and with full system pressure will cost tens of thousands of dollars a year. Consult the maintenance manual to determine how periodic maintenance should best be accomplished.

- Air Dryers – Air dryers are an important tool for maintaining air quality. They may serve the main air lines, special equipment with a need for especially dry air or they may serve to provide breathing air. Typically they are either desiccant air dryers or refrigeration dryers. Both types use air or electrical energy, respectively, even with very low flows. If the dryers are not needed, shut them down. For example, two air dryers may be in service to provide breathing air to a weld booth. Isolate the backup dryer if only the capacity of one is needed. Also consider shutting air dryers down when equipment is not being used. When air dryers are installed in parallel, shutdown some of the dryers during periods of reduced load at night or weekends. This can result in significant savings during shutdown periods.

Air Supply

The air demand reduction efforts will be useless if the compressor configuration cannot be set to take advantage of the reduced demand. The key here is to match the compressor capacity to the demand and produce the needed air as economically as possible.

Compressor System Operation Optimization

- It is important to match the compressor capacity to the air demand. To accomplish this, it is necessary to understand how a particular compressor system meets the demand that is presented. Typically for centrifugal compressors, demand between about 100% and 70% capacity is met by throttling the compressor inlet vanes. If the compressor is throttled below the surge point, typically in the area of 70% capacity, the compressor will surge. To prevent this and still meet demands, the compressor will open a bypass or dump valve. The dump valve will take air from the compressor discharge and return it to the compressor inlet or exhaust it to the roof. In any case this air is dumped or

bypassed. This air is essentially wasted together with the energy used to produce it.

- It is important that operators understand these concepts and properly control the system to minimize energy use. Plant air load can vary substantially from full production, to breaks or lunchtime, to shutdown periods. Air load during an extended shutdown can decrease to as little as 10% that of full production. In meeting the load, the operator must consider a variety of factors including expected load swings, redundancy requirements, and minimizing starts on large compressor motors to that allowed by the manufacturer.
- Other types of compressors may be available in some plants. It is important to understand compressor efficiency as a function of load and the various control schemes utilized so the compressors can be operated in the most efficient configuration. A good way to check on the efficiency of a particular configuration is to monitor power (kW) or current (A) to the various compressors or on the compressor busses for a given situation. Most AAM locations have power monitoring that tracks the number of running compressors at a given time, the loading status of each compressor, and the total energy used to operate the compressed air system.

Compressor Production Cost

Knowing the cost for producing air from each available compressor can help determine which compressors should run to minimize cost. Typically integrated compressor control systems will provide reports that show compressor operating costs in terms of $/MCF ($/thousand cubic feet of air) or in terms of kW/MCF. All else being equal, the operators should be instructed to run the most economical compressors as base loaded units and place the next most expensive compressors in service as demand increases. This practice will maximize the use of the most economical compressors and minimize the use of the least economical. Obviously, one must consider loading issues as discussed above to get the most economical mix to support the operation. Usually larger compressors are more economical, however if a large portion of their air is bypassed the total operation will not be cost effective.

Backup Capacity

An extra compressor kept in service just in case one of the operating compressors fails or automatically shuts down can be a concern. This can be an expensive practice, especially if a substantial portion of the capacity is bypassed or dumped through the blowoff. If reliability of the compressors is driving this concern, the compressors should be overhauled and possibly have the controls upgraded so they can be reliably counted on. Similarly, having an operator start a compressor that is ready to be started or using an auto start capability may allow the backup compressor to be shutdown.

Automatic Starts

An unnecessary automatic start of a large compressor during the peak electrical demand period can result in setting the monthly electrical demand several hundred kilowatts higher than need be. This may occur if air use is near the capacity of the running compressors. Operators can monitor electrical load during peak periods and take appropriate action to prevent unnecessary auto starts. This may include shifting compressor configurations during periods of low load to ones with more margins. Another approach would be to take the standby compressor out of the automatic mode and rely on the operator to start it if really needed. Unnecessary starts may be caused by high momentary demand that the plant can ride through. If this is a chronic problem, one must investigate the source and consider installing accumulators near the equipment imposing the demand.

Compressor Maintenance

Compressor maintenance is important but often deferred because the compressor is still "running". A good preventative maintenance program will ensure the reliability needed so it is not necessary to run a backup compressor as described above.

- As a centrifugal compressor wears it becomes less efficient and the surge point will decrease. To prevent inadvertent surges, the control settings need to be modified to open the bypass at progressively higher flows. This reduces the span of control as described above and will result in more blowoff and less efficient operation. Compressor overhauls are expensive but need to be performed at vendor recommended intervals. The lost efficiency and lost span of control can easily result in substantially higher operating costs.
- It is also important to do surge testing periodically to account for wear on a compressor. After an overhaul it is very important to perform a surge test so the surge set points can be reset and the span of control regained by the overhaul can be realized in operation.

Design Issues

Operating experience and system analysis may identify modifications that can reduce operating costs with relatively short payback periods. In addressing some of the operating issues discussed above, it may become apparent that modifications are worth looking into. The following items are some common compressed air system retrofits that have proved cost effective:

Compressor Sizing

If air produced cannot be matched to the demand and there are continuous periods of bypass or blowoff, it may be appropriate to add a smaller compressor to the system. For example, adding a compressor of 50% the size of existing compressors may make it easier

to match various loads. When adding new capacity to support plant expansion it may be worth considering this aspect in sizing the new compressors.

Air Inlet Temperature

Reducing compressor inlet temperature can substantially improve compressor efficiency. A 10-degree reduction in temperature can reduce compressor load by about 2%. If the air inlet to the compressors is inside the plant consider moving it outside to a cool location such as the north side of the building and away from other sources of heat. Use average outside temperature to calculate the savings. Even if the intake line is outside, be sure it is as far from other heat sources as possible.

NOTE: The change from summer to winter temperatures can significantly impact compressor performance. It may take over 10% more energy to meet plant needs in the summer than in the winter.

Waste Heat Recovery

Much of the energy used to compress air is removed by the after coolers, which cool compressed air to useable temperatures. A high percentage of this heat can be removed and used in the plant. Typically, this is a relatively low temperature. The most common application is building heating. A lot of heat can be generated from compressor load of a couple megawatts. Compressor manufacturers often offer heat recovery systems that can economically recover this heat.

Integrated Controls

Installation of an integrated compressor control system is probably the most cost effective upgrade. It takes into account the various issues discussed in the two sections above and optimizes integrated performance. Performance improvements of 10 to 20% are often achieved. The following are some of the key benefits from such a system:

Optimizes surge set point.

The surge set point depends on a number of parameters. To be conservative and prevent unwanted surges, discrete systems typically are set so the surge set point is higher than if all parameters are considered. The integrated system dynamically sets the surge set point based on actual operating conditions. The result is that the control range may be expanded as much as 10% thus reducing blowoff and wasted energy.

System Information

The system provides a wealth of information including information on compressor relative efficiency, which allows one to use the most efficient compressors. The control system

also can provide daily and monthly historical reports showing system cost, blowoff, compressor operating history, system load, and system pressure. This information is a key tool to optimizing system performance.

Automatic sequencing and loading

The system will automatically load compressors in the most economical manner as air demand increases. The system can also automatically start compressors to meet load demand.

Despite all the benefits of an integrated control system, it is not a system that can be installed and forgotten. Although it might appear that it has replaced the operator, just the opposite holds true. If one is to get full benefit from the system and the information it provides, it is necessary for operators to be trained and actively involved in using the information provided to optimize system performance. Because of the extensive use of sensors to control surge points and control the system, sensors must be calibrated periodically. Since the system allows you to operate closer to the surge points, compressors should be tested for surges periodically. Finally, it is important that the compressors be kept in good running order to get the full benefit from the system. After installation of a new integrated control system, the instrumentations may tell you that the compressors are not working up to their capabilities and need to be overhauled.

Documentation

Good documentation can greatly assist in managing a compressed air system. It will help to minimize the cost of producing the compressed air and it can also assist in monitoring air usage practices. An integrated control system, as discussed previously, can do an excellent job of keeping historical operating records. The following are some parameters that one should consider documenting and monitoring on a periodic basis to assess overall system operation:

1. Compressor production costs or energy use (kW/mcf or $ /miff)
2. System pressure needed to support various conditions such as operation, short down time, extended shutdown
3. System air demand – This will help pinpoint changes in plant operations that are using more air. Also monitor air demand during shutdown as an assessment of the plant leakage level and the effectiveness of the leak repair program. To accomplish this, monitor air use Sunday morning at 3 AM, for example, when the plant is shutdown and little maintenance work is in progress.

Lighting Systems

Process

Identifying opportunities for lighting load reductions requires a tour of the plant observing work in progress and area lighting during production and shutdown periods. This may need to be done several times for consistency purposes. The following are things to look for during walkthroughs:

- Occupancy Patterns – Look for occupant areas and determine how often they are used. Some areas may be used only for a few hours a day. If or when the area is vacant, energy reduction efforts can be applied.
- Lighting Shutdown Process – Verify lights are shutdown when not being used. This involves talking to people to determine their understanding of how lights are controlled and their responsibility to turn them off. Determine where existing light switches are located and whether the lighting is tied to the EMS or if occupancy sensors are installed.
- Unnecessary Lights – Look for lights that serve no useful functions. Develop a list of lights that can be disconnected or removed. Look for areas where equipment is abandoned or infrequently used so lights may be turned off. If an area is well lit by sunlight, shut down some lights during daylight hours.
- Inoperable Lights – Look for lights that are not functioning properly. This may include burned-out or dimmed lights.

After identifying opportunities, develop an action plan to reduce the energy used for lighting and improve lighting where needed. The following are different ways to implement this:

- Develop a Process to Shut Off Lights – Where the survey indicates, develop a plan to shutoff lights in areas that are not continuously occupied. This can be done by the following:
    - Curtailment Plans
    - Having workers shut off lights when area is not in use
    - Installing occupancy sensors
- Employee Shutdown Education – Work with the responsible work group to educate employees on the expectations. The following are ways to help communicate these:
    - Posters identifying impacted lights – Place posters reminding employees to shut off lights or where switches are located.
    - Supervisor and management support – The goal here is to help change habits by monitoring behavior and effectiveness while reinforcing expectations.

    - Publicize energy saving expectations – Use the media to emphasize the need to shut off lights

- Disconnect unnecessary lights – Develop a list of unnecessary lights that can be disconnected and disconnect them.

Lighting System Maintenance

Improving lighting system maintenance practices has the potential to save energy, reduce the cost of lighting maintenance and improve light levels in the plant. The following are ways to improve lighting system maintenance:

- Group Re-lamping – Group re-lamping involves replacing all the lamps in an area at a given time rather than waiting for the bulbs to burn out individually. This can help save maintenance costs. Replacing one bulb at a time is at least four times more expensive than group re-lamping. The rule of thumb is to replace the bulbs at 50-70% of the bulb design's life. The exact point of replacement should be determined on a case-by-case basis by monitoring lamp performance in a facility. By doing this, one can also improve lighting in works areas.

- Bulb Upgrades – There are always new bulb designs that have improved color quality, extended bulb life, and reduced electrical energy needed for operation. Bulb upgrades can be implemented as part of a group re-lamping shift. When upgrading bulbs, it is important to know the exact fixtures and ballast types installed to assist in identifying appropriate options. Knowing the lights' height and distance between lights can help determine if the replacement will meet the foot-candle requirement for the specific application.

- Lamp Replacement Guide – Bulbs must be matched with the fixture and ballast to function properly, and this can be a challenge with the various bulb replacements. An improper match may lead to poor light quality, reduced bulb life, or damage to the ballast, bulb, and fixture. Develop a guide to help electricians in bulb replacement. The guide may include a map, information for identifying various fixtures and ballast types along with a corresponding list of acceptable replacement bulbs.

Light System Upgrades

Lighting system upgrades usually involve replacing light fixtures or installing equipment to facilitate light shutoff. One can find opportunities during model changes, plant expansions, and facility upgrades. The following are a few possible upgrades:

- Installing Light Switches – In some areas, it may not be possible to turn off lights due to inconvenient switch locations or because of links with breakers. It is recommended to place switches near area entrances or normal access routes. Installation of occupancy sensors is another practical solution.

- Install Timers or an Energy Management System – This is an effective method to control many lights in areas where occupancy is predicable (such as shift times or daylight hours).
- Occupancy Sensors – Occupancy sensors are a great way to save energy and have merely no impact on the area's occupants. They can adjust to a variety of occupancy patterns without needing to change the program, such as with an EMS.
- Replacing Light Fixtures – This covers mostly everything discussed above in "Lighting System Maintenance". This should also include, however, allocating lights so that they can be easily accessed or replacing lights fixtures that have cheap maintainability features.

Records

Good records and documentation should be kept to help in maintenance functions:

- Light fixtures types map – This should include a list of the types of fixtures used in the plant, and the type of lights they support.
- Bulb Replacement and Re-Lamping Records – This should be a document or list of the date, area, and types of bulbs used for re-lamping. This should also include a record of when bulbs begin to fail to help determine when group re-lamping is necessary.
- Curtailment Information – This should include information on which lights should be shutdown, when they are shutdown, and who is responsible for shutting them down (with a list of back-ups)

HVAC Systems

The Building Envelope

Building openings can be a significant source of wasteful energy. Wind may force cold air into the building where it must be heated, or the building may be positively or negatively pressurized based on outside air stillness. In any case, energy must be added to the building to provide comfortable working conditions for the associates. The following are possible paths for cold air to enter the building:

- Truck and Vehicle Doors – These can be a significant source of cold air leakage when left opened. Damage to these doors can also be a reason for air leakage. The following are ways to help resolve these issues:
    - Keep door curtains, ramps, corner pillows, and doors in good repair. Be sure the door closes tightly against the floor or ramp, and the ramp pulls up to seal with the door.

- Be sure doors are closed when loading or unloading is not actively in progress. Even with a truck in the door, there may be an opening of several square feet.
- At the start of a shutdown period, make sure that all doors are tightly shut. If a door is damaged, fix it. If a door does not close tightly at the bottom, close it manually and repair it.
- Where double doors are present, be sure that both doors are operable and tightly shut. Make sure that the first door is shut before the second.
- If doors do not make a good seal with various truck configurations, one should consider upgrading doors and curtains to seal around trucks better.
- Automated high speed doors can be used for areas under frequent use in order to prevent drivers leaving doors opened for convenience, and to minimize open time while vehicles pass through the door.

- People Doors – Although not as big as truck doors, these can still be a significant cause for air leakage. The following are ways to help resolve these issues:
  - Be sure doors are in good working order with tight weather stripping seals on all sides. A door with a crack of a fraction of an inch at the bottom can cost several hundred dollars over the heating season.
  - Where double doors are present, make sure both are kept closed.
  - Doors in remote areas such as penthouses may be left open and should be closed.
- Building Leaks – A building may have leaks due to modification, poor construction practices, or damage. Look for openings around truck doors, pipes, or special openings to facilitate automated material entry, or trash disposal. These can be resolved by metal flashing, caulking, and insulation.
- Insulation – This may not be the most cost effective method of saving energy, however at times the cost of energy loss exceeds the cost of repair. Typically, the roof will be the area where this can be most economically applied.
- Building Pressurization – By keeping the building tightly sealed, one can increase the amount of warm air leaking out rather than cold air leaking in. This helps maintain more personal comfort.

Cooling Systems

Cooling is usually provided by ventilation exhaust fans or by chillers. In addition, small air conditioning units may be used to cool office areas and some work areas. Chillers and air conditioning units can significantly increase plant load during the summer. Actions can be taken to ensure that the cooling system is working as efficiently as possible.

- Chiller Loading – Most systems have several chillers. As cooling demand increases and decreases, chillers should be placed in service and taken out of

service. Chillers operate most efficiently when they are fully loaded. Similarly, support equipment such as cooling tower fans, cooling water pumps, and chiller pumps should be shutdown when they are not needed. It would be appropriate to develop written guidelines to be sure all operators know the most efficient combinations considering outside temperature, humidity, and plant demand.

- Chiller Maintenance – Air conditioner compressor maintenance is important. One should periodically run a performance test to confirm efficiency.
- Protected Thermostat Settings – Thermostats should be protected in order to prevent people from inputting settings that would require more energy to maintain.
- Chiller Cooling Towers Maintenance – Maintaining cooling tower chemistry is important. Tower basins should be inspected periodically and cleaned to remove debris that may blow into the tower basins and corrosion products that precipitate into the basin.
- Heat Exchanger Performance Check – One should check heat exchanger performance periodically and inspect them to verify their performance is not impeded by scale or debris build-up.

Records

It is important to maintain the following information:

- Historical information on chiller and heat exchanger performance.
- Air balance information, especially damper positions. This will assist in resetting dampers if plant personnel move them.
- Temperature maps of the plant floor will help diagnose problems and provide a more comfortable working environment.

Chapter 5 – Curtailment Plan

Types of Shutdowns

The goal of a good curtailment plan is to reduce energy use and correlating costs to a minimum during shutdown periods. Typically, shutdowns are classified as follows:

- Shift Shutdowns – Plant is operated on one or two shifts and shutdown for part of the night.
- Weekend Shutdowns – A one or two day shutdown.
- Holiday Shutdowns – When a plant is shut down for a 3 or 4 day weekend. [NOTE: Occasionally a holiday will occur mid week and result in a one day shutdown. Though technically a holiday, we will use this term to refer to the longer shutdown. A single day holiday will be treated as a one day weekend.]
- Maintenance Shutdown – A shutdown for a week or more.

Shutting down specific lines in plants that produce several products is another saving opportunity. Walking through the plant during shutdowns to observe which equipment is running effectively assesses energy usage. There will regularly be unnecessary running equipment, such as task lighting being left on when no work or maintenance is in progress, ventilation exhaust fans running, open truck doors, etc…

Shutdown Energy Requirements and Employee Support

Energy is still required to support maintenance and other activities in progress during shutdown periods. The energy should be used as effectively and efficiently as possible.

It is important for plant personnel to understand the energy curtailment plan and how their role applies to it. They may be required to turn off lights and equipment as necessary to support maintenance and the curtailment plan. A plant personnel's knowledge of equipment, conditions, and other types of activities and maintenance performed can help develop support for the curtailment program and provide useful feedback to update the program.

Making a Curtailment Plan Work – Obstacles

One of the most frequent obstacles is equipment not being shut down in fear that equipment will not be properly restarted when it is time to restart production. The most important rule of the curtailment plan is:

If a necessary piece of equipment is shutdown at the end of production, it must be restarted before production can start!

The curtailment plan should include a formal procedure on how to shutdown and restart equipment, checklists, or visual reminders to ensure both a smooth shutdown and restart.

With this, a list of people who are responsible for shutting down and restarting equipment should be included. A curtailment plan requires good team work and the development of new habits to inhibit success.

Management plays a vital role to the success of a curtailment plan. It is their responsibility to support the program, monitor implementation, keep the program up to date, and facilitate emerging obstacles.

Tools and Methods

The following are different ways of turning equipment on and off:

- Energy Management System (EMS) – A very efficient method to implement a curtailment plan and requires little man power. It must be used in addition to the rest of the curtailment activities in order to be effective. The EMS, however, may not be able to control all items in a manner consistent with the curtailment plan. Thus, it will be necessary to manually shutdown some items not tied into the EMS.
- Administrative and Support Staff – Administrative, Engineering, and support staff should be expected to shutdown any equipment at their work stations when not in use (i.e. desk lights, computers, heaters, fans, etc…). They should also shutdown lights in conference rooms, bathrooms, conference rooms, etc. in their vicinity. It is understood that some equipment may need to be left on for other purposes.
- Maintenance and Production Workers – Production personnel should shutdown as much as possible during and after their shifts. This may include shutting off nearby lights, computers, printers, exhaust fans, etc… A proper way to ensure this is by coming up with the following:
    - Work Station Check List – This should be a card or sheet describing items being shut down and when they are shutdown/restarted.
    - Check Sheets – These can be formatted as necessary to ensure shutdown procedures. Laminated paper or posters with grease pencils is a good way of doing this.
- Shutdown Letters – A letter to inform plant personnel of which items will be shut down. Typically, these letters will be sent out if a shutdown lasting week or longer is to be expected.

What to Have in Mind

Setting Goals and Benchmarks

Typically, a good goal would be to extend the shutdown for as long as possible. One can shutdown more equipment during a weekend than during a weeknight. A good aggressive goal is to reduce electrical loads by 50% during a night shutdown and by 25% during a shutdown of at least two days.

Estimating Savings

The best way to estimate savings is by actually implementing part of the curtailment plans and measuring results for future reference. It is possible, however, to make estimations by counting light fixtures, estimating loads for equipment, and determining shutdown periods.

Coming Up With a Plan

The first step in coming up with a plan is to do a complete review of the entire plant, and what equipment is being used during a shutdown period. The next step would be to assess the value of equipment being left on. Talking to plant personnel during shutdowns, walking through the plant, and gathering electrical and natural gas information are all good ways of doing this. Lastly, after analyzing the information, one should have enough information to come up with a plan that keeps energy usage to a minimum.

Lighting

During a shutdown, perform a walk-through to determine where one can shut down unnecessary lights. The need for lighting varies between production and non-production hours. Lights should be made available when needed and shut down when not needed. The following are possible solutions to ensure an efficient curtailment:

- Energy Management System (EMS) – The EMS is a system that shuts off or turns on lights at scheduled times. The schedule is to be carefully coordinated to ensure lights are on when needed, and not shut off during possible extended production periods. The EMS can be overridden from the plant floor.
- Production / Maintenance Personnel – Personnel should turn on and shut off lights when needed. This can usually be done using light switches. If no light switches are in the immediate area, it may be necessary to install them near entrances or easily accessible areas for convenience. This may be applied in storage rooms, infrequently used inspection areas, filter houses, etc… Make sure to use posters and signs to help remind personnel of their responsibility to shut off lights.
- Occupancy Sensors – These can automatically shut off lights in an area when it is not occupied. They are an excellent way to control lights in infrequently occupied areas.

Ways to Prevent Error

A shutdown rounds routine sheet is an excellent way to develop an efficient, detailed and formal process for turning on and shutting off lights in a building. The following is a description of how to establish this process:

Final Proposed Process

- Weeknights
  1. Shutdown part or all with the EMS for high-bay
  2. Rounds check list for some / limited low-bay
- Weekends
  1. Shutdown all low-bay using rounds check list
  2. Leave some or all high-bay operating depending on work level.
- Who should shutdown?

  Determine who will shutdown the lights and develop rounds sequence and path for each. This may be done with one or several people.

Human Factors

- Load Lists: Put list in each lighting panel with at least the loads we are shutting down.
- Mark Lighting Breakers: Mark breakers green circle next to breaker with green paint stick. One need not look at breaker numbers or list; just turn off / on "green" breakers. To start until one has had a chance to dry run several times, use round green file folder stickers.
- Mark Lighting Panel Columns: May want to mark panel columns with green band 1 foot wide at about 10 foot level. This would help people find lighting panels to restore lights when needed for maintenance. The concept behind this is that lights are turned on as needed by maintenance personnel and turned off again when work is complete.
- Develop Shutdown Lists and Routes: Develop shutdown lists that can be used by the number of people assigned to efficiently shutdown lights for weeknights, weekends, or extended shutdown periods. List would be along an efficient path showing panel location and breakers to be turned off. Breakers sequence would be reversed to restore lighting.

Steps to Implement

- Initial survey
  1. Survey each lighting panel. Cycle each breaker and list visible lighting loads
  2. Check light levels with final configuration for acceptability
  3. Look for other items to include in the shutdown plan such as exhaust fans
  4. Develop preliminary shutdown lists and rounds path
- Check Shutdown Process

1. Label panels with missing breaker numbers
2. Mark breakers to be used with round green stickers
3. Use preliminary list a couple of times
4. Update list and revise as needed.

- Finalize List / Mark Panels
  1. Finalize shutdown lists – laminate shutdown rounds sheet and breaker lists
  2. Finalize load list and post in panels
  3. Mark green circle next to shutdown breakers in panel with green paint stick
  4. Mark columns to facilitate locating
- Implement new Shutdown Routine
- Monitor Implementation – This should include monitoring electrical load in the area before and after lighting shutdown as a test case to determine potential savings. Other loads should be shutdown to minimize interference from other activities. The results can then be used to assist in monitoring performance during subsequent shutdowns. It is also useful to periodically walk through the area during shutdowns to observe how well the plan is being implemented. This should include discussions with various personnel to determine how effective the program is and what issues may have developed.

The steps to implement the plan may be different for various plants. The general process should be adapted to the available hardware and personnel.

Electric and Natural Gas Consumers

There is several equipment in a plant that can be shutdown to limit electrical or natural gas energy usage during a shutdown period. The following are ways to help ensure this:

- Compressed Air -
  - ✓ Be sure all pneumatic lifts and production lifting devices are not carrying loads nor have parts in them. Reduce the number of running air compressors and blowoff.
  - ✓ Isolate any air tools that have a high use of air during shutdown periods. (Examples: Rivet guns that use air to feed the rivets, automated fastener handling devices, vacuum holding devices used to hold labels or parts, etc.)
  - ✓ Air blowoff curtains should be shutoff or valved out of service.
  - ✓ Cleaning – Do not use compressed air for cleaning. Use a vacuum cleaner or other method.
  - ✓ Isolate any air headers where possible. This may be feasible for several days of an extended shutdown.

- ✓ Be sure to reduce the number of compressors to match the compressed air load and minimize amount of compressor blowoff or bypass. Also shutdown desiccant or refrigeration air dryers not needed to support the lower compressed air load.

- Conveyors - Shutdown all conveyors as soon as they are no longer needed to support production. It may not be possible to shutdown conveyors in some paint areas.
- Washers – Shutdown pumps, blowers, and exhaust fans on washers when production stops.
- Computers, Monitors and Printers – Shutdown computers, monitors, printers and other computer support equipment in the plant at workstations
- Other Items – Consider other support systems such as hydraulic pumps, dedicated air compressors, electric tools, measuring equipment, etc. All should be considered for shutdown.

HVAC Systems

There are several ways to help reduce HVAC loads during shutdown periods. The following are ways to do this:

- Shifting Building Temperature Set Points – Shifting building temperature set points can save a significant amount of energy. In the winter, one would reduce building temperatures, and in the summer one would raise it. A complication that may come with it is that the plant associates may not be as comfortable as it would during production periods. During complete shutdown periods of no work, temperatures may be shifted toward even further levels to achieve higher savings. However, it is important that these temperatures be restored back to normal settings before production starts again.
- Reduce Building Air Turnover - Reducing building air turnover may be accomplished by shutting down space heating units, exhaust fans, or throttling back on outside air dampers depending on system configuration. Since fewer people occupy the building, and process pollutants are greatly reduced, building air turnover needed to support production is not necessary. Turnover can be reduced by a factor of 10 or more. This significantly reduces the outside air that needs to be heated or cooled.

Truck Dock Doors and Heaters

Modern truck doors are designed with curtains that provide relatively good seals with normal trucks and door heaters that are interlocked to shutdown when the door is closed. However, the open space may be a couple of square feet. In older plants, even with door curtains that are in good condition, the opening to the outside may be several square feet. Damaged curtains may provide openings of 20 or 30 square feet. Depending on wind

conditions and pressure of the building, air will transfer either in or out of the building through these holes. In winter or summer this represents a very large energy loss that must be made up by the plant heating or cooling system, respectively. It is especially important to keep doors shut when outside temperatures are different then those desired inside. This may be accomplished as follows:

- Shut Truck Doors when active loading is not in progress
- Shutdown dock heaters when the plant is shutdown

Personnel should monitor doors and heaters immediately after shutdown to be sure doors are shut and heaters are turned off. Personnel shutting down other equipment in the building should do this.

Attachment # 7

AAM Energy Newsletter

LEADING CHANGE NOW! AAM 2008

Energy Newsletter

Volume 1 Issue 1 – March 2008

Message from the Chairman

Richard E. Dauch
Co-Founder,
Chairman of the Board & CEO

Welcome to the premier issue of AAM's "Energy Newsletter." The goal of this Newsletter is to inform the AAM community about the escalating energy-related issues and AAM's corresponding strategy.

In today's market, preventive measures must be in place to withstand all challenges regarding cost reduction and process efficiency improvements. With energy costs escalating rapidly at an average annual rate of 8%, the per-unit profit margin continues to erode. In addition, the depletion of natural resources and the effect of carbon-dioxide emissions into the environment triggers the necessity of an effective energy management.

Energy management is a key component for reducing operating costs, boosting productivity, creating value and increasing profits. Each one of us has the responsibility to "Do the right thing." Every AAM associate must do his part to reduce energy cost by reducing energy consumption at our facilities.

In 2008, AAM will implement the following energy conservation initiatives:

- Development of an Energy policy and corresponding conservation strategies.
- Associate education and awareness
- Benchmarking of Energy performance

These initiatives will ultimately produce corporate culture shift in energy management.

Y GreEn ?

To rearrange our view of EnerGY for a healthier environment !

AAM Energy Policy

Commitment
Escalating and volatile energy cost compromises American Axle & Manufacturing profitability. Therefore, as part of its manage for profit strategy, AAM is committed to serious and responsible energy management and will practice energy efficiency throughout its facilities, reducing energy costs by using and purchasing it in the most cost-effective ways possible within safe practices and environmental conditions.

Objective
AAM will continuously improve its energy performance where possible. It will implement this policy without compromising safety, reliability, and environmental conditions by establishing and implementing an effective Energy Awareness and Management Program.

Goals
- Incorporate energy efficiency in daily activities to maximize the possibility of identifying energy saving opportunities.
- Use energy as efficiently as practicable throughout the Company's production and non-production facilities.
- Evaluate the plants' current equipment to identify energy saving opportunities.
- Incorporate energy efficiency into the selection of new equipment for production and non-production facilities.
- Purchase energy from suppliers that best fit AAM cost and quality needs.
- Reduce pollution, particularly CO_2 emissions indirectly caused by AAM energy use.

Applicability
This policy shall apply to all American Axle & Manufacturing facilities and subsidiaries, business units, and associates, worldwide.

Administration
The AAM Energy Team will be responsible for administrating this policy, as well as evaluating and updating the policy to reflect changing needs and priorities.

Sharing the Power

AAM continues to focus on electrical & natural gas energy consumption. By saving **28 million** kilowatt-hours (kWh), AAM has contributed to the community; lowering overall electrical demand (kW). This helps to maintain energy prices by allowing more loads to be added to the power grid without modifying the capacity. The table to the right helps put this in perspective by showing what can powered for an hour equating to AAM's energy curtailment efforts in 2007:

Product	Electrical Energy per Hour (kW)*	Quantity
AAM Saved in 2007	**3,196**	**1**
TV	0.16	19,977
Electric Shaver	0.015	213,090
DVD Player	0.035	91,324
Laptop	0.075	42,618
Average Household	1.14	2,804

**The total energy usage from 2007 (28 million kWh) was divided by the # of hours during the year (8,760) for this comparison.*

AAM Continuous Improvement

The American Axle & Manufacturing World Headquarters Building was designed for energy efficiency, yet following a continuous improvement approach, the WHQ building took the lead performing a lighting assessment to cut down the building's electrical load. By reducing the amount of lamps per fixtures from 3 to 2, and changing the lighting schedule during weekdays, the electrical load for lighting can be reduced by **9%** during office hours. It is expected that AAM plants follow this initiative, especially on proven high-energy areas such as compressed air, HVAC, pumps, heat process, etc. Recent studies showed that compressed air and air tempering account for an important portion of the total electrical load, **13%** and **14%** respectively.

Best Energy Efficiency Practices...

- Turn off all non-essential lighting.
- Turn off unused air compressors.
- Isolate tools that have a high use of air.
- Do not use compressed air for cleaning.
- Shutdown all production-related equipment when feasible.
- Reduce compressed air pressure if possible.
- Reduce the number of operating air supply houses.
- Turn off outside lights during daytime.
- For obsolete equipment no longer in use, shutoff electrical power and isolate compressed air and steam.
- Locate and repair compressed air leaks ASAP.

Best Practices for Heating Season

- Close outside doors to cut heat loss including truck door heaters .
- Shutdown exhaust fans when not required
- Reducing heating load by setting thermostat at 65 ºF
- Seal cracks and openings to reduce infiltration.
- Insulate wall, ceiling, and floors when feasible.
- Use the sun's heat by opening drapes, shades, and blinds during the day.
- Close off unused rooms and turn off heat in these areas if possible

A Breath of Fresh Air

Carbon dioxide (CO_2) emissions are known as a significant contributor to the earth's health depletion. CO_2 is naturally absorbed by trees. Therefore, lowering CO_2 emission would be like planting trees to control the environment's CO_2 content. In 2007, AAM helped preserve the atmosphere by reducing CO_2 emissions by **24,700** Tons. If one soft wood tree processes 0.787 Tons of CO_2 / year, then …

Curtailment Efforts → **Equates to Planting**

100 cm circumference soft wood trees

31,000

If you have any suggestion or feedback, please contact:

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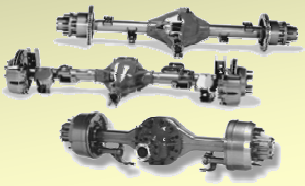
LEADING CHANGE NOW! AAM 2008

Energy Newsletter

Volume 1 Issue 2 – October 2008



Message from the Vice Chairman

Yogen N. Rahangdale
Vice Chairman & Chief Technology Officer

In today's turbulent business environment we face three critical issues; economy, emissions, and energy. Energy savings help in all three areas. Nowadays it is clear to everyone the benefit of effective energy curtailment to all. Whether it be to lessen the cost of your local utility bill or simply create the healthiest environment possible, AAM aims to be a proactive leader regarding energy issues. Therefore, I am pleased to provide our associates with the second issue of the AAM Energy newsletter. The goal of this issue is to continue the spread of energy savings to promote the safest and cleanest environment, and financial benefit to AAM.

Even during a slow time of economic growth, AAM will continue to invest toward the well-being of our environment . Therefore, I encourage all AAM associates to adopt energy efficiency practices at home and their work place to collaborate with the company during such difficult times. This issue begins by presenting simple energy savings ideas that will help us to alleviate high energy demand during the cold season.

Cold cues for Winter

With the winter season around the corner, all facilities should be getting ready to face colder weather. Winterization is a key factor to reducing natural gas and steam costs during the cold season. Hence, AAM encourages everyone to reduce the impact of high energy prices on our economy by implementing the following energy efficiency practices. Feasibly putting some of these practices into place outside of the AAM community will further boost our environmental well-being.

Efficient Winterization Practices:

•Keep the building envelope as tight as possible to prevent heat loss:
- •Keep outside doors and windows closed.
- •Seal cracks and openings to reduce infiltration.

•Shutdown exhaust fans when not required.
•Open shades to use sun heat during the day, but leave them closed for the night.
•Isolate unused rooms and turn the heating off in these areas if possible.
•Reduce the heating load by setting the thermostat @ 65F
•Repair steam leaks in plants where it is used for heating and production.
•Make sure that the heating system is running efficiently. So, if possible, give preventive maintenance to the space heating equipment in order to tune and optimize performance before lost opportunities occur.

Proactive Approach:

Winterization should not take our attention from other potential energy saving opportunities. Hence, everyone is encouraged to implement the following recommendations:.

•Reduce compressed air usage and pressure during weekends and holidays.
•Repair compressed air leaks.
•Reduce lighting above idled equipment.
•Turn off all non-essential lighting, including non-production hours (i.e. idle shift periods) and outside during daytime.
•Shutdown hydraulic pumps, mist collectors & coolant pumps when equipment is not running.
•Isolate utilities to all idled equipment if possible.

AAM Achievements

•The new contract with National Grid and NYPA at **Buffalo** yields **$86k / month** in energy cost savings. This was accomplished through a combination of negotiation with the utility companies and curtailment efforts to reduce electrical energy to below 500kW during time of no activities.
•A capacitor bank was installed to improve the low Power Factor (PF) at **Detroit.** The new capacitor bank will lessen the quantity of utility power generated, and maintain the PF above the minimum required (85%). This resulted in saving to about **$10,000 / month** effective August 2008.
•Starting on October the 1st, a **9%** reduction in electricity cost per kWh is expected at Oxford Forge by selecting the appropriate contract based on the plant's load.
•Natural Gas contract negotiation for Michigan, Ohio, and WNY will render about **$1 million** per year in savings.
•A recent energy audit in Detroit will yield over $300k / year in energy savings by curtailing the electric load during non-production periods.

Up Coming Activities

ESA Energy Audit:

The Department of Energy (DOE) will conduct various free Energy Savings Assessments (ESA) at a few AAM locations. The main objective of each assessment is to identify potential energy savings opportunities within the facility. Additionally, the ESA is also focused on training the plant personnel assisting in the audit. Familiarity with the SSAT assessment tool in the real industrial plant environment will also be gained. All techniques and practices learned during the assessment will be used later to:
•Monitor the outcome of the assessment.
•Track the implementation of any recommendation and its benefits to AAM.
•Search for more potential opportunities in the future to maximize savings.

The AAM locations to be assessed for the upcoming audits include:
• Detroit Site (Heat Treat Furnaces, Compressed Air, Steam)
•Three Rivers (Steam)
•Colfor (Heat Treat Furnaces)

Benefit to Society

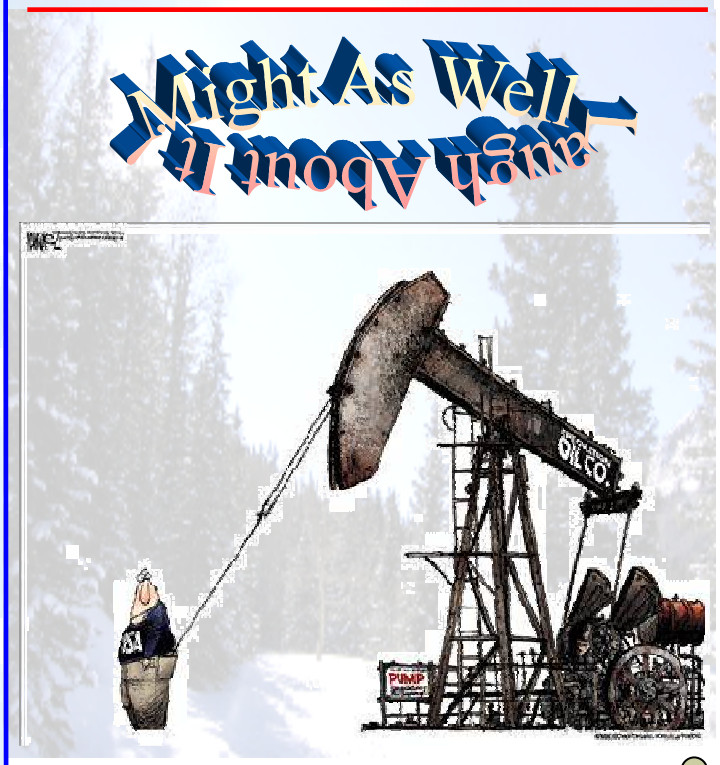
Despite the work stoppage, AAM manufacturing plants managed to reduce energy usage with respect to sales and weather conditions. From January through July, the overall reduction translated to a CO_2 emissions cutback of about **9,602** metric tons. The table below lists the major contributors towards this total:

Site	EstimatedTons of CO2 Reduction	Energy Usage in MMBtu
	Total Tons of CO2 Reduction	% Reduction
Mexico	3,696	-7%
Malvern	1,431	-7%
MSP	1,409	-10%
3R	1,050	-6%
Albion	752	-9%

The figure below puts AAM energy curtailment efforts into perspective:

Curtailment Efforts → **Equates to Planting**

12,000 *100 cm circumference soft wood trees*



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LEADING CHANGE NOW! AAM 2008

Energy Newsletter

Volume 1 Issue 3 – December 2008

Message from the Executive Vice President, Worldwide Operations

John J. Bellanti
EVP Worldwide Operations

The holiday season is upon us and as I write this article I can't help but reflect back on a difficult year for AAM and for our entire nation. While AAM's stock trades are at their lowest, I remain optimistic about AAM's future.

In today's economy, the cost of energy (electricity, natural gas & steam) has increased to astronomical rates. In less than a decade, electricity has doubled in cost and natural gas has increased four-fold.

Energy is a significant cost for the continuing operation of our facilities. Although natural gas costs have dropped since October 2008, no one expects prices to return to their pre-2000 rates, nor remain low. High energy costs are with us now and will continue to deplete profits and income.

Actions need to be taken immediately to reduce these energy costs. The most effective strategy to reduce energy cost and get more for our energy dollar is to reduce energy demand and consumption. The most economical way to do this is to "**TURN IT OFF**" when the equipment is not needed and not in use. Employee education and sometimes a simple sign reminder is sufficient.
In addition to saving energy and reducing utility expenses, preserving more of our natural environment and sending a signal to the world that AAM is fully committed to implementing eco-conscious methods is also at stake.

"It's not the Age, It's the mileage"- Its logical that a car driven 25% less each year will last longer. The same is true for most energy-consumption equipment. By turning the equipment "OFF" when it is not needed, a financial jackpot is found which extends beyond the utility budget. Listed below are some overlooked benefits of energy conservation and these are benefits that can be attained without a negative impact on productivity.

Budgetary Improvements: In addition to utility budget reduction, equipment will last longer due to reduced operation per year making replacements less frequent; thereby, reducing capital budget requirements and maintenance costs.

Long Term Strategic Benefit: Organizations that conserve/manage energy (reducing emissions) can differentiate themselves as "environmentally friendly" and eco-conscious members of the community. These have tremendous political, strategic, competitive and morale building value.

For 2009, the AAM corporate Energy reduction goal is 5% over 2008 usage. Every AAM associate is responsible to meet the goal. In the recently published "Energy Management Handbook" there are some guidelines that can be used to achieve and beat the reduction target. On the last 2008 working day we encourage all associates to follow the shutdown guidelines provided in this newsletter.

As we celebrate this holiday, it's more important than ever to be thankful for family, friends, and the many things that we sometimes take for granted. So let me take this opportunity to wish you and your loved ones a happy and healthy holiday season.

Reduce at Recess

The mandated mission of corporate-wide energy reduction has proven to be a success. Through the first three quarters of the year, we have saved about 4.5% of expected energy usage in 2008. Before we take well-deserved time off to be with friends and family during the annual holiday shutdown, let's close the year strong. Below are some energy curtailment rules of thumb that may be helpful to implement during the 12-day break:

Lighting

•Lighting should only be on in areas of production or maintenance
•Outside lighting should only be on during dark hours
•Office lighting should only be on where necessary

Air Compressors

•If feasible, no compressors should be ran
•Only air compressors in use are to be powered on
•Run the compressor that will best fit the shutdown demand
•Air compressors are not to be used for cleaning

Heating

•Reduce the heating thermostat to 60ºF making sure we do not cause pipe freeze
•Shut all doors to prevent facility heat loss
•All dock heaters should be turned off

Processes

Where feasible, turn off all:

•Exhaust Fans
•Pumps
•Blowers
•Conveyors
•Unused Equipment
•Steam for equipment and doughnut heaters
•Boilers

If you have any suggestion or feedback, please contact:

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Mission Accomplished

During the 2008 year, AAM has been committed to reducing the 2% energy goal set at the beginning of the year. We are currently on pace to more than double that goal by reducing about 4.5%. This mark has been attained through hard work and close attention to detail by AAM associates. The table below shows some of our top performers during the 2008 year:

Energy Scorecard Summary Table: January - September 2008

Site	YTD % Reduction	Savings
MSP	-12.6	$226,856
Malvern	-12.5	$190,835
Albion	-10.5	$246,380
TF	-10.4	$286,568
3R	-9.0	$231,308
Mexico	-7.7	$1,067,289

Quick Holiday Tip:

Try using tinsel and mirrored ornaments instead of additional lights in order to limit the necessary electricity.

Have a safe and happy holiday!