ADVANCED LIGHTING STRATEGIES

STAN WALERCZYK, LC
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BIO

- 19 years experience
  - Distribution, maintenance, installer, retrofit contractor, consultant, designer, researcher
- 500+ projects
- 30+ published articles
- 400+ seminars
- IESNA member
  - Effects of Lamp Spectral Distribution Committee
  - Served on Energy Management Committee
    - Past chair of Retrofit/Upgrade Subcommittee
- CLEP by AEE
- Lighting Certified by NCQLP
- Project manager for California Lighting Technology Center
- Assisted Brian Liebel at AfterImage+Space on spectrally enhanced lighting research for the DOE
- Consultant for PG&E on California Title 20
- Several IIDA Awards

SO MUCH INFO
SO LITTLE TIME

- Please hold questions and comments until end or after seminar
- If no handouts or if some tables are too small, email me at stan@lightingwizards.com and I will send them
- Background info available by emailing me
  - Best Practice Report
  - MH vs. FLUORESCENT - 10 Rounds In The Hibay Arena
- Background info at www.lightingwizards.com
  - DOE Reports on Spectrally Enhanced Lighting
  - Dimming Ballasts - Buyer Beware
  - and more

NO ENDORSEMENTS

- Although several manufacturers and models are listed, none are endorsed
- Easier to talk about specifics than generalities

FOLLOWING 8 SLIDES WERE IN YESTERDAY'S SEMINAR FOR ENERGY MANAGERS, BUT WILL NOT BE DISCUSSED TODAY

S/P Benefits of 5000K 3000+ Lumen F32T8s

lamp	mean photopic (catalog) lumens	S/P ratio	brightness $P(S/P)^{.5}$	paper $P(S/P)^{.78}$	computer $P(S/P)^{1.0}$
F34T12 CW	2300	1.50	2817	3156	3450
F34T12 WW	2350	1.00	2350	2350	2350
F32T8 730	2650	1.19	2891	3035	3154
F32T8 735	2650	1.30	3021	3252	3445
F32T8 741	2650	1.56	3310	3749	4134
F32T8 830 2nd	2800	1.29	3180	3415	3612
F32T8 835 2nd	2800	1.41	3325	3661	3948
F32T8 841 2nd	2800	1.62	3564	4079	4536
F32T8 830 3rd	2950	1.29	3351	3598	3806
F32T8 835 3rd	2950	1.41	3503	3857	4160
F32T8 841 3rd	2950	1.62	3755	4298	4779
F32T8 850 3rd	2860	1.95	3994	4815	5577
Increase of energy efficiency of 3000+-initial-photopic-lumen 850 3rd generation F32T8s when considering full field of view compared to		**CW**	**42%**	**53%**	**62%**
		WW	**70%**	**105%**	**137%**
		730	**38%**	**59%**	**77%**
		735	**32%**	**48%**	**62%**
		741	**21%**	**28%**	**35%**
		830 2nd	**26%**	**41%**	**54%**
		835 2nd	**20%**	**32%**	**41%**
		841 2nd	**12%**	**18%**	**23%**
		830 3rd	**19%**	**34%**	**47%**
		835 3rd	**14%**	**25%**	**34%**
		841 3rd	**6%**	**12%**	**17%**

notes : Lumens and S/P ratios can vary among lamps and manufacturers.

Prepared by Stan Walerczyk, www.lightingwizards.com, 4/9/06 version

INCREASED EFFICIENCY & ENERGY SAVINGS

If the increase in efficiency is:	The energy savings are:
10%	9%
20%	17%
30%	23%
40%	29%
50%	33%
75%	43%
100%	50%
200%	67%
300%	75%

Increased efficiency = (improved lumen per watt / base case lumens per watt) - 1

Energy savings = (base case KWH - improved KWH) / base case KWH

For increases in energy efficiency, the low number is base case, working from low to high.

For energy efficiency, the high number is base case, working from high to low.

Prepared by Stan Walerczyk of Lighting Wizards, based on the work of Brian Liebel of AfterImage+Space.

S/P Info for 32W F32T8s and 34W F34T12s

lamp	mean photopic (catalog) lumens	S/P ratio	brightness $P(S/P)^{.5}$	paper $P(S/P)^{.78}$	computer $P(S/P)^{1.0}$
F34T12 CW	2300	1.50	2817	3156	3450
F34T12 WW	2350	1.00	2350	2350	2350
F32T8 730	2650	1.19	2891	3035	3154
F32T8 735	2650	1.30	3021	3252	3445
F32T8 741	2650	1.56	3310	3749	4134
F32T8 830 2nd	2800	1.29	3180	3415	3612
F32T8 835 2nd	2800	1.41	3325	3661	3948
F32T8 841 2nd	2800	1.62	3564	4079	4536
F32T8 830 3rd	2950	1.29	3351	3598	3806
F32T8 835 3rd	2950	1.41	3503	3857	4160
F32T8 841 3rd	2950	1.62	3755	4298	4779
F32T8 850 3rd	2860	1.95	3994	4815	5577
F32T8 865	2750	2.20	4079	5087	6050
F32T8 880	2518	2.50	3981	5146	6295

notes : Lumens and S/P ratios can vary among lamps and manufacturers.

Listed F32T8 865 is Sylvania XPS. Listed F32T8 880 is Sylvania Skywhite XP.

Prepared by Stan Walerczyk, www.lightingwizards.com, 10/24/07 version

4' LINEAR FLUORESCENT EFFICACY TABLE

4' lamp type	*lamp lumens*	*lamp watts*	*lamp lumens per lamp watts*	*lamp quant*	*ballast type*	*standard ballast factor*	*system watts*	*initial system lumens*	*initial system lumens per watt*	*mean or 8000 hour lumen maint-enance*	*mean or 8000 hour system lumens*	*mean or 8000 hour system lumens per watt*
high performance F32T8	3100	32	96.9									
	3100	32	96.9									
	3100	32	96.9									
extra long life 2950 lumen F32T8	2950	32	92.2									
	2950	32	92.2									
basic grade F32T8	2800	32	87.5									
	2800	32	87.5									
30W F32T8	2850	30	95.0									
	2850	30	95.0									
28W F32T8	2750	28	98.2									
	2750	28	98.2									
25W F32T8	2440	25	97.6									
	2440	25	97.6									
extra long life 25W F32T8	2400	25	96.0									
	2400	25	96.0									
high lumen F28T5	3050	28	108.9									
typical F28T5	2900	28	103.6									
26W F28T5	2900	26	111.5									
26W high lumen F28T5	3050	26	117.3									
51W F54T5HO	5000	51	98.0									
typical F54T5HO	5000	54	92.6									
F34T12 800	3100	34	91.2									
F34T12 CW	2650	34	77.9									

notes: Lumens, lumen maintenance, ballast factors and wattages may vary among various manufacturers.

In enclosed fixtures, since reduced wattage F32T8s consume less heat they can often operate closer to optimal 77 degrees F temperature, so may provide more light than this table shows compared to full wattage.

Although efficacy can be improved with IS and RS ballasts with T5s and T5HOs, lamp life can be greatly reduced and lamp manufacturers may not warranty lamps.

93% is used as an average EOL lumen maintenance for T5HOs. 90% - 94% range among manufacturers.

All wattages based on 277V. EE IS is extra efficient instant start. G IS is generic instant start. EE PS is extra efficient program start. PS is program start. RS E is rapis start electronic. RS M is rapid start magnetic.

Extra long life is 36,000 hours with IS and 40,000 hours with PS ballasts at 3 hour cycles.

Prepared by Stan Walerczyk of Lighting Wizards www.lightingwizards.com 11/1/07 version

4' LINEAR FLUORESCENT EFFICACY TABLE

4' lamp type	*lamp lumens*	*lamp watts*	*lamp lumens per lamp watts*	*lamp quant*	*ballast type*	*standard ballast factor*	*system watts*	*initial system lumens*	*initial system lumens per watt*	*mean or 8000 hour lumen maint-enance*	*mean or 8000 hour system lumens*	*mean or 8000 hour system lumens per watt*
high performance F32T8	3100	32	96.9	2	EE IS	0.87	53	5394	101.8	95%	5124	96.7
	3100	32	96.9	2	EE IS	1.20	73	7440	101.9	95%	7068	96.8
	3100	32	96.9	2	G IS	0.87	58	5394	93.0	95%	5124	88.4
extra long life 2950 lumen F32T8	2950	32	92.2	2	EE IS	0.87	53	5133	96.8	95%	4876	92.0
	2950	32	92.2	2	G IS	0.87	58	5133	88.5	95%	4876	84.1
basic grade F32T8	2800	32	87.5	2	EE IS	0.87	53	4872	91.9	95%	4628	87.3
	2800	32	87.5	2	G IS	0.87	58	4872	84.0	95%	4628	79.8
30W F32T8	2850	30	95.0	2	EE IS	0.87	51	4959	97.2	95%	4711	92.4
	2850	30	95.0	2	G IS	0.87	55	4959	90.2	95%	4711	85.7
28W F32T8	2750	28	98.2	2	EE IS	0.87	48	4785	99.7	95%	4546	94.7
	2750	28	98.2	2	G IS	0.87	51	4785	93.8	95%	4546	89.1
25W F32T8	2440	25	97.6	2	EE IS	0.87	42	4246	101.1	95%	4033	96.0
	2440	25	97.6	2	G IS	0.87	47	4246	90.3	95%	4033	85.8
extra long life 25W F32T8	2400	25	96.0	2	EE IS	0.87	42	4176	99.4	95%	3967	94.5
	2400	25	96.0	2	G IS	0.87	47	4176	88.9	95%	3967	84.4
high lumen F28T5	3050	28	108.9	2	EE PS	0.95	58	5795	99.9	92%	5331	91.9
typical F28T5	2900	28	103.6	2	PS	1.00	64	5800	90.6	92%	5336	83.4
26W F28T5	2900	26	111.5	2	EE PS	0.95	55	5510	100.2	92%	5069	92.2
26W high lumen F28T5	3050	26	117.3	2	EE PS	1.15	67	7015	104.7	92%	6454	96.3
51W F54T5HO	5000	51	98.0	2	EE PS	1.00	108	10000	92.6	92%	9200	85.2
typical F54T5HO	5000	54	92.6	2	PS	1.00	117	10000	85.5	92%	9200	78.6
F34T12 800	3100	34	91.2	2	RS E	0.85	60	5270	87.8	92%	4848	80.8
F34T12 CW	2650	34	77.9	2	RS M	0.88	72	4664	64.8	87%	4058	56.4

notes: Lumens, lumen maintenance, ballast factors and wattages may vary among various manufacturers.

In enclosed fixtures, since reduced wattage F32T8s consume less heat they can often operate closer to optimal 77 degrees F temperature, so may provide more light than this table shows compared to full wattage.

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All wattages based on 277V. EE IS is extra efficient instant start. G IS is generic instant start. EE PS is extra efficient program start. PS is program start. RS E is rapis start electronic. RS M is rapid start magnetic.

Extra long life is 36,000 hours with IS and 40,000 hours with PS ballasts at 3 hour cycles.

Prepared by Stan Walerczyk of Lighting Wizards www.lightingwizards.com 11/1/07 version

4' T8 LAMP LIFE, LUMENS, CRI & MERCURY

LAMP	WATTS	4100K		5000K		MAX MG OF MER-CURY	LAMP LIFE HOURS WITH VARIOUS BALLASTS & CYCLES					
		CATA- LOG LUMENS	CRI	CATA- LOG LUMENS	CRI		INSTANT START		RAPID START		PROGRAM START	
							3 HR	12 HR	3 HR	12 HR	3 HR	12 HR
1st GENERATION - GENERIC - LOW MERCURY	32	2800	75-78	2800	75-78	1.7 - <10	15,000 - 20,000	20,000 - 28,000	20000 - 25,000	24,000 - 28,000	20000 - 25,000	24,000 - 28,000
2nd GENERATION - GENERIC - LOW MERCURY	32	2950	81-85	2800 - 2950	80-85	1.7 - <10	15,000 - 20,000	20,000 - 28,000	20000 - 25,000	24,000 - 28,000	20000 - 25,000	24,000 - 28,000
GE HL	**32**	**3100**	**82**	**3000**	**80**	**3.95**	**24,000**	**29,000**	**24,000**	**29,000**	**24000+**	**29000+**
PHILIPS ADVANTAGE	**32**	**3100**	**85**	**3100**	**85**	**1.7**	**24,000**	**30,000**	**30,000**	**36,000**	**30,000**	**36,000**
PHILIPS PLUS	**32**	**2950**	**85**	**2850**	**85**	**1.7**	**30,000**	**36,000**	**36,000**	**42,000**	**36,000**	**42,000**
PHILIPS EXTRA LONG LIFE 32W	**32**	**2950**	**85**	**2850**	**85**	**1.7**	**36,000**	**40,000**	**NA**	**NA**	**40,000**	**46,000**
SYLVANIA XPS	**32**	**3100**	**85**	**3000**	**85**	**3.5**	**24,000**	**36,000**	**36,000**	**42,000**	**36,000**	**42,000**
SYLVANIA XP XL	**32**	**2950**	**85**	**2900**	**85**	**3.5**	**36,000**	**40,000**	**40,000**	**46,000**	**40,000**	**46,000**
GE WM	**30**	**2850**	**81**	**2750**	**80**	**3.95**	**20,000**	**24,000**	**NA**	**NA**	**20000+**	**24000+**
GE XL WM	**30**	**2800**	**81**	**2700**	**80**	**3.95**	**24,000**	**29,000**	**NA**	**NA**	**24000+**	**29000+**
PHILIPS ADV EW	**30**	**2850**	**85**	**2850**	**85**	**3.5**	**24,000**	**30,000**	**NA**	**NA**	**30,000**	**36,000**
SYLVANIA FO30 SS	**30**	**2850**	**85**	**2800**	**85**	**3.5**	**24,000**	**36,000**	**36,000**	**42,000**	**36,000**	**42,000**
SYLVANIA FO28 SS	**28**	**2725**	**85**	**2650**	**80**	**3.5**	**24,000**	**36,000**	**36,000**	**42,000**	**36,000**	**42,000**
GE F28	**28**	**2750**	**82**	**2650**	**80**	**3.95**	**18,000**	**24,000**	**NA**	**NA**	**18000+**	**24000+**
PHILIPS ENERGY ADV 28W	**28**	**2725**	**85**	**2650**	**85**	**1.7**	**24,000**	**30,000**	**NA**	**NA**	**30,000**	**36,000**
GE F32T8/25W/SPX/ECO	**25**	**2400**	**85**	**2350**	**80**	**3.95**	**36,000**	**40,000**	**40,000**	**46,000**	**40,000**	**46,000**
PHILIPS ENERGY ADV 25W	**25**	**2475**	**85**	**2400**	**85**	**1.7**	**24,000**	**30,000**	**NA**	**NA**	**30,000**	**36,000**
PHILIPS EXTRA LONG LIFE 25W	**25**	**2400**	**85**	**2300**	**85**	**1.7**	**36,000**	**40,000**	**NA**	**NA**	**40,000**	**46,000**
SYLVANIA FO32/25W SS	**25**	**2475**	**85**	**2350**	**85**	**3.5**	**24,000**	**36,000**	**36,000**	**42,000**	**36,000**	**42,000**
F34T12CW	34	2650	60	NA	NA	4.4-10	NA	NA	20,000	27,000+	NA	NA
F28T5	26-28	2900+	85	2750+	85	1.4 - 5.0	*	*	*	*	20,000 - 30,000	25000 - 36,000
F54T5HO	51-54	5000	85	4800+	85	1.4 - 5.0	*	*	*	*	20,000 - 30,000	25000 - 36,000

Lamp manufacturers may alter rated lamp life and lumen specifications, so get updates from manufacturers.

Some manfacturers may have higher ratings for basic and mid grade T8s.

GE lamp life may be as good as equivalent lamps from Philips and Sylvania with program start ballasts, but GE is being conservative at this time.

Program start ballasts include fixed output and most dimming ballasts. All ballasts, except for T12, are electronic.

Even though listed as NA (not applicable/available) some rapid start & program start ballasts can operate some 25-30W lamps.

Prepared by Stan Walercyk of Lighing Wizards 11/1/07 version. www.lightingwizards.com

25 - 32W F32T8 LAMP AND ELECTRONIC BALLAST WATTAGE TABLE

ballast type >>>>>>>>>			GEB IS									EE IS									EE PS									GEB RS or PS
lamp type >>>>>>>>>>			32W	30W			28W			25W			32W	30W			28W			25W			32W	30W			28W			25W			32W
system wattage >>>			**X**	**X**			**X**			**X**			**X**	**X**			**X**			**X**			**X**	**X**			**X**			**X**			**X**
system W saved >>>>					X			X			X				X				X			X					X				X		
lamp W saved >>>>>>						*X*			*X*			*X*				*X*			*X*			*X*				*X*			*X*			*X*		
	BF																																	
SUPER LOW BF																																		
1	number of lamps	0.60																																
2																							**44**											
3																							**66**											
4																																		
EXTRA LOW BF																																		
1	number of lamps	0.71																					**25**	**23**	2	*2.0*	**22**	3	*3.0*	**21**	4	*4.0*		
2																							**46**	**43**	3	*1.5*	**40**	6	*3.0*	**38**	8	*4.0*		
3																							**71**	**66**	5	*1.7*	**62**	9	*3.0*	**56**	15	*5.0*		
4																							**91**	**86**	5	*1.3*	**80**	11	*2.8*	**73**	18	*4.5*		
LOW BF																																		
1	number of lamps	.75 - .78	**29**	**28**	1	*1.0*	**26**	3	*3.0*	**23**	6	*6.0*	**25**	**24**	1	*1.0*	**22**	3	*3.0*	**21**	4	*4.0*												
2			**51**	**48**	3	*1.5*	**45**	6	*3.0*	**41**	10	*5.0*	**48**	**45**	3	*1.5*	**42**	6	*3.0*	**38**	10	*5.0*												
3			**76**	**70**	6	*2.0*	**67**	9	*3.0*	**61**	15	*5.0*	**72**	**67**	5	*1.7*	**64**	8	*2.7*	**57**	15	*5.0*												
4			**98**	**90**	8	*2.0*	**86**	12	*3.0*	**78**	20	*5.0*	**95**	**88**	7	*1.8*	**84**	11	*2.8*	**75**	20	*5.0*												
STANDARD BF																																		
1	number of lamps	.87 - .90	**31**	**29**	2	*2.0*	**28**	3	*3.0*	**25**	6	*6.0*	**28**	**27**	1	*1.0*	**25**	3	*3.0*	**23**	5	*5.0*	**28**	**27**	1	*1.0*	**25**	3	*3.0*	**24**	4	*4.0*	**32**	
2			**58**	**55**	3	*1.5*	**51**	7	*3.5*	**47**	11	*5.5*	**53**	**51**	2	*1.0*	**48**	5	*2.5*	**42**	11	*5.5*	**55**	**52**	3	*1.5*	**48**	7	*3.5*	**44**	11	*5.5*	**62**	
3			**86**	**81**	5	*1.7*	**76**	10	*3.3*	**69**	17	*5.7*	**80**	**76**	4	*1.3*	**71**	9	*3.0*	**64**	16	*5.3*	**81**	**76**	5	*1.7*	**71**	10	*3.3*	**66**	15	*5.0*	**91**	
4			**112**	**105**	7	*1.8*	**98**	14	*3.5*	**90**	22	*5.5*	**106**	**100**	6	*1.5*	**95**	11	*2.8*	**85**	21	*5.3*	**108**	**100**	8	*2.0*	**96**	12	*3.0*	**87**	21	*5.3*	**119**	
REFERENCE BF																																		
1	number of lamps	.96 - 1.04	**36**	**34**	2	*2.0*	**33**	3	*3.0*	**30**	6	*6.0*	**34**	**32**	2	*2.0*	**30**	4	*4.0*	**29**	5	*5.0*												
2			**66**	**62**	4	*2.0*	**59**	7	*3.5*	**52**	14	*7.0*	**62**	**59**	3	*1.5*	**55**	7	*3.5*	**50**	12	*6.0*												
3			**92**	**87**	5	*1.7*	**81**	11	*3.7*	**73**	19	*6.3*	**89**	**84**	5	*1.7*	**78**	11	*3.7*	**73**	16	*5.3*												
HIGH BF																																		
1	number of lamps	1.15 1.20	**41**	**39**	2	*2.0*	**36**	5	*5.0*	**34**	7	*7.0*	**38**	**36**	2	*2.0*	**33**	5	*5.0*	**32**	6	*6.0*												
2			**78**	**73**	5	*2.5*	**68**	10	*5.0*	**62**	16	*8.0*	**73**	**70**	3	*1.5*	**64**	9	*4.5*	**60**	13	*6.5*	**74**											
3			**111**	**105**	6	*2.0*	**97**	14	*4.7*	**88**	23	*7.7*	**109**	**104**	5	*1.7*	**97**	12	*4.0*	**93**	16	*5.3*	**108**											
4			**144**	**135**	9	*2.3*	**123**	21	*5.3*				**143**	**136**	7	*1.8*	**128**	15	*3.8*	**122**	21	*5.3*	**144**											
average W reduction with .71 - .90 BF					*1.7*			*3.2*			*5.5*				*1.3*			*2.8*			*5.0*				*1.6*			*3.1*			*4.7*		

Footnotes for this table are listed in next sheet of this file.

Prepared by Stan Walerczyk, principal of Lighting Wizards, www.lightingwizards.com, 9/5/06 version

RETROFIT, RELAMP, RELIGHT & REDESIGN OPTIONS FOR TYPICAL INDIVIDUAL OFFICE WITH 2X4 18 CELL PARABOLIC 3F32T8-700 TROFFERS

$0.15	blended KWH rate	3600	annual hours	$0.05	utility or 3rd party incentive for first year KWH reduction	15	number of years for cumulative long term benefit

existing					18 options to consider (shorter paybacks do not always provide better long term benefits)											
fixture type	quan - tity	total watts	annual elect'l cost	lamp life @ 3 hour cycles	#	4R	quan - tity	products	total watts	annual elect'l savings	incen- tive	appr. installed cost	simple payback in years	lamp life @ 3 hour cycles	long term benefit
2x4 18 cell parabolic troffers each with 3 F32T8 735s or 741 lamps and 3-lamp .88 BF generic instant start electronic ballast (originally inboard/ outboard switching)	2	172	$92.88	18,000 average (15,000 to 20,000 range)	1A	retrofit	2	3 32W F32T8 850s & .6 BF EE PS ballast	114	$34.45	$10.44	$120.00	3.2	24K	$429.72
					1B	retrofit	2	3 32W F32T8 850s & TW .6 BF PS ballasting	91	$48.11	$14.58	$140.00	2.6	30K	$618.79
					2A	retrofit	2	3 32W F32T8s & .77 BF EE IS ballast	144	$16.63	$5.04	$100.00	5.7	24K	$177.02
					2B	retrofit	2	3 32W F32T8s & TW .77 BF EE IS ballasting	115	$33.86	$10.26	$120.00	3.2	24K	$420.63
					3A	retrofit	2	3 28W F32T8s & .87 EE IS ballast	142	$17.82	$5.40	$100.00	5.3	18 - 24K	$172.70
					3B	retrofit	2	3 28W F32T8s & TW .87 BF EE IS ballasting	114	$34.45	$10.44	$120.00	3.2	19 - 24K	$407.22
					4A	retrofit	2	3 25W F32T8 850s & .87 EE IS ballast	126	$27.32	$8.28	$110.00	3.7	20 - 24K	$308.14
					4B	retrofit	2	3 25W F32T8 850s & TW .87 EE IS ballasting	101	$42.17	$12.78	$130.00	2.8	21 - 24K	$515.39
					5A	retrofit	2	3 25W F32T8 835/841s & 1.0 BF EE IS ballast	144	$16.63	$5.04	$110.00	6.3	22 - 24K	$144.52
					5B	retrofit	2	3 25W F32T8 835/841s & TW 1.0 BF EE IS ballasting	115	$33.86	$10.26	$130.00	3.5	23 - 24K	$388.13
					6A	relamp	2	3 28W F32T8s & use existing ballast	155	$10.10	$3.06	$25.00	2.2	24 - 24K	$109.53
					6B	relamp	2	3 25W F32T8 850s & use existing ballast	140	$19.01	$5.76	$30.00	1.3	25 - 24K	$230.88
					7A	upscale retrofit	2	ALP RDI ACR type of kit with 2 32W F32T8 850s & .77 BF EE IS ballast	96	$45.14	$13.68	$250.00	5.2	24K	$1,235.84
					7B	upscale retrofit	2	ALP RDI ACR kit with 2 32W F32T8 841s & .87 BF EE IS ballast	106	$39.20	$11.88	$250.00	6.1	24K	$1,144.94
					7C	upscale retrofit	2	ALP RDI ACR type of kit with 2 32W F32T8 835s & 1.0 BF EE IS ballast	130	$24.95	$7.56	$250.00	9.7	24K	$926.78
					8A	redesign	1	new 8' suspended indirect fixture with good batwing distribution, 2 32W F32T8 850s & 1.15 BF IS ballast	73	$58.81	$17.82	$480.00	7.9	24K	$4,237.41
					8B	redesign	1	new 8' suspended indirect fixture with good batwing distribution, 2 32W F32T8 841s & 1.32 BF EE IS ballast	85	$51.68	$15.66	$480.00	9.0	24K	$4,128.33
					8C	redesign	1	new 8' suspended indirect fixture with good batwing distribution, 4 32W F32T8 835s & .77 BF IS ballast	96	$45.14	$13.68	$480.00	10.3	24K	$4,028.34

notes: Prepared by Stan Walerczyk, LC, Principal of Lighitng Wizards. February 20, 2006 version

Delamping these parabolic troffers is not an option, because it ruins proper cut-off angles, which can greatly increase direct, indirect and overhead glare.

Listed 32W F32T8s are high performance ones that are rated for 3100 catalog lumens, 82 - 86 CRI and 24,000 hour rating with IS ballasts at 3 hour cycles

25W F32T8s may not be recommended with occupancy sensors or other short cycle applications, especially with existing ballasts.

EE = extra efficient. BF = ballast factor. IS = instant start. PS = program start. TW = tandem wiring using 1 2-lamp & 1 4-lamp per fixture pair to allow for board/outboard switching.

Wattages are based on 277V line voltage and may be higher with 120V. Lower wattages with higher Kelvin lamps are based on scotopically enhanced lighting.

With some states' prevailing wages and union rates, can be considerably less labor costs to retrofit than replace fixtures.

In options, total watts is reduced 20% in options that inboard/outboard switching is re-introduced, because not all lamps will be on all of the time.

Annual electrical savings include 10% for reduced air conditioning load. In some areas this would be higher, and in other areas this would be lower.

Although this table includes an incentive for 25W and 28W F32T8s with new EE ballasts, some programs do not include them, because long term savings cannot be guarranteed.

long term benefit = (annual elect. savings x number of years) + incentive - initial installed cost. Small adder for 24,000 hour rated lamps and using fewer lamps. Because of increased productivity,

$50/year for baskets and $150 - $250/year added for suspended indirects. $250 is 1/2 of 1% improvement on $50,000 salary. 0.05% is not wasting 2.5 minutes/day.

Regarding long term benefits, cost of money is considered to be offset by increases in electricity, majority of maintenance savings and increases in worker salaries.

KWH rate, annual hours, incentive rate, and length of long term benefit can all be easily changed in colored/shaded boxes. Ballasts are typically rated for 15 years, fixtures much longer.

ALTHOUGH HPS & STANDARD MH HIBAYS SHOULD BE REPLACED, DO NOT GIVE UP ON MH

HIGH PERFORMANCE MH, T5HO & T8 HIBAY COMPARISON

Following are some examples

lamp, ballast & dome/reflector type	lamp life at 10 hour cycles	CRI	initial total lamp lumens	BF	actual initial total lamp lumens	EOL lamp lumen maint-enance	EOL total lamp lumens	lumin-aire effic-iency	EOL lamp luminaire lumens	sys-tem watts	EOL lamp luminaire lumens per watt	Kelvin	S/P ratio	EOL lamp luminaire task modified lumens	EOL lamp luminaire task modified lumens per watt
320W quartz PS MH lamp, magnetic reactor ballast, high performance dome	20,000	65	32,000	0.97	31,040	65%	20,176	92%	18,562	345	54	4000	1.65	27,432	80
320W quartz PS MH lamp, electronic ballast, high performance dome	20,000+	65	32,000	0.97	31,040	75%	23,280	92%	21,418	335	64	4000	1.65	31,653	94
high Kelvin quartz 375W PS MH lamp, electronic ballast, high performance dome	20,000+	90+	28,000	0.97	27,160	75%	20,370	92%	18,740	391	48	5000	2.10	33,428	85
320W ceramic MH lamp, electronic ballast, high performance dome	20,000+	90	38,800	0.95	36,860	80%	29,488	92%	27,129	335	81	4000	1.80	42,909	128
320W ceramic MH lamp, electronic ballast, super high performance dome	20,000+	90	38,800	1.00	38,800	80%	31,040	94%	29,178	335	87	4200	1.80	46,149	138
4 F54T5HO 4100K lamps, electronic ballasts, enhanced aluminum reflector	33,000+	85	20,000	1.00	20,000	92%	18,400	92%	16,928	234	72	4100	1.65	25,017	107
4 GE 51W F54T5HO 4100K lamps, extra efficient electronic ballasts, enhanced aluminum reflector	33,000	85	20,000	1.00	20,000	92%	18,400	92%	16,928	216	78	4100	1.65	25,017	116
6 high lumen F32T8 4100K lamps, instant start electronic ballasts, enhanced aluminum reflector	28,000+	85	18,600	1.18	21,948	92%	20,192	91%	18,375	218	84	4100	1.65	27,156	125
6 high lumen F32T8 4100K lamps, program start electronic ballasts, enhanced aluminum reflector	34,000+	85	18,600	1.15	21,390	92%	19,679	91%	17,908	216	83	4100	1.65	26,465	123
6 high lumen F32T8 5000K lamps, 1.0 BF instant start electronic ballasts, enhanced aluminum reflector	28,000+	85	18,000	1.00	18,000	92%	16,560	91%	15,070	178	85	5000	1.95	25,370	143
6 Philips extra long life F32T8 5000K lamps, program start electronic ballasts, enhanced aluminum reflector	44,000	85	17,100	1.15	19,665	92%	18,092	91%	16,464	216	76	5000	1.95	27,717	128
6 F32T8 6500K lamps, 1.0 BF instant start electronic ballasts, enhanced aluminum reflector	28,000+	85	17,100	1.00	17,100	92%	15,732	91%	14,316	178	80	6500	2.25	26,948	151
6 Sylvania Skywhite F32T8XP 8000K lamps, 1.0 BF instant start electronic ballasts, enhanced aluminum reflector	28,000+	88	15,900	1.00	15,900	92%	14,628	91%	13,311	178	75	8000	2.50	27,203	153

Notes

BF stands for ballast factor and EOL stands for end of life. Not all electronic ballasts for MH start the lamps the same, use the same wattage, etc.

High performance domes include clear prismatic, metal faceted or glass lined metal faceted. 320W CMH data is preliminary.

Initial lumens for ceramic MH lamps with some electronic ballasting is at least 5% higher than catalog listing with magnetic ballasting.

IMPORTANT! Fluorescent lamp lumens are based on optimal temperatures & can be adjusted with lumen/temp tables provided by manufacturers.

Luminaire dirt depreciation could be included if you know it. All line voltages are considered to be 277.

End of life luminaire task modified lumens = end of life lamp luminaire lumens x $(S/P)^{.78}$ [.78 exponent]. Task modified lumens less for lower Kelvin.

Prepared by Stan Walerczyk of Lighting Wizards, 8/28/07 version.

REGARDING PREVIOUS TABLE

- Fluorescent lumens are based on optimal temperatures, which is typically not the case
- High performance T8 systems are so much better than standard T5HO systems, do not understand why so many people try to push T5HOs
  - Although the new GE 51W F54T5HO lamps and extra efficient ballasts are better than standard T5HO systems, they still are not nearly as good as high performance T8 systems

CAN'T DO AN 'ADVANCED LIGHTING STRATEGIES' SEMINARS WITHOUT INCLUDING

LEDs

THANK YOU DOE

- The United States Department Of Energy is promoting SSL in order to save energy, including
  - Helping to prevent repeating the mistakes with CFLs
  - CALiPERS
  - Fact sheets
  - Webinars
  - Energy Star
  - Standards Development
- The DOE is also funding research on spectrally enhanced lighting, mainly fluorescent
- I cannot think of a better way to spend my tax dollars

BE AN INFORMED BUYER

- **Bottom-line: understand and request SSL luminaire testing**
- **ENERGY STAR® for SSL** is coming shortly
  - Effective date set for September 30, 2008
  - Products tested for:
    - Total luminous flux (light output) of luminaire
    - Luminaire efficacy
    - Correlated Color Temperature
    - Color Rendering Index
    - Intensity distributions
    - Steady State Module/Array Temperature
    - Maximum Power Supply Case/TMP Temperature

Source: U.S. Department of Energy

DOE SOLID-STATE LIGHTING WEBSITE

- Current information on SSL program, progress, and events
- SSL publications: roadmaps, reports, technical fact sheets
- Solicitations
- Register for ongoing SSL UPDATES at: www.netl.doe.gov/ssl

Source: U.S. Department of Energy

LED TO LED RETROFITS

- Over the last 10 years about 80% of my retrofit work has been T8 to better T8 systems
- With the expected continued rate of LED improvements and replaceable LED modules, it sure looks like LED to better LED retrofits will also be cost effective
  - So it might not matter if LEDs last 50,000 hours or longer, because maybe in 3, 4 or 5 years, LED modules or panels could be replaced with fewer ones or lower wattage ones
    - Where and when prevailing type wages are not required, older LED fixtures in the future could be replaced with new lower wattage LED fixtures

GIVE CUSTOMERS A CHOICE OF TECHNOLOGIES

- Although high performance fluorescent and HID may be more cost effective now, those technologies can be considered mature, so probably not that much improvement in the future
- But LEDs technology is relatively new and based on the laws of chemistry and physics has so much potential for improvement
  - LEDs improving about 35% lumens per watt per year and pricing is coming down about 20% per year

GIVE CUSTOMERS A CHOICE OF TECHNOLOGIES

- So, especially in prevailing wage and union situations, I give customers a choice of technologies
  - Some pick the safe tried and true mature option
  - Others pick LEDs
    - Some pick LEDs because are what called energy geeks or early adopters or want to make a statement for their institution
- The following tables do not include extra savings from potential LED to better LED retrofits down the road

TYPICAL COVERED GARAGE

$0.140	KWH rate			$0.05	/KWH 1st year saved rebate	15	years of long term benefit								
existing				proposed											
fixture & application type	unit watts	annual hours	annual electrical cost	option letter	retrofit/replacement option description	watts	watts redux	annual electrical savings	appr. incentive	appr. installed cost	rated lamp life @ 12 hour cycles	payback just electricity	payback including maint-enance savings	long term benefit just electricity	**long term benefit including maint-enance savings**
175W MH ceiling fixture with 10,000 hour rated lamp and magnetic ballast	210	8760	$257.54	A	new triangle fixture with 3 3000 - 3100 lumen F32T8 850 lamps, 1.00 BF extra efficient instant start ballast & 3 C or inverted L reflectors	89	121	$148.39	$53.00	$360	30,000	2.1	1.7	$1,919	**$2,809**
				B	new triangle fixture with 3 3000 - 3100 lumen F32T8 850 lamps, 1.15 BF extra efficient program start ballast & 3 C or inverted L reflectors	109	101	$123.87	$44.24	$370	46,000	2.6	1.8	$1,532	**$2,647**
				C	Philips 120W PLH CFL, socket and electronic ballast	136	74	$90.75	$32.41	$180	20,000	1.6	1.5	$1,214	**$1,486**
				D	100W long life CMH lamp & electronic ballast	110	100	$122.64	$43.80	$180	20,000	1.1	1.0	$1,703	**$2,071**
				E	new LED fixture with good distribution and 4 panels, each with 20 1W LEDs (may be able to use existing mounting)	98	112	$137.36	$49.06	$1,000	50,000 - 100,000 (less for driver)	6.9	4.8	$1,109	**$2,346**
				F	new LED fixture with good distribution and 3 panels, each with 20 1W LEDs (may be able to use existing mounting) (need to check for sufficient light)	73	137	$168.02	$60.01	$900	50,000 - 100,000 (less for driver)	5.0	3.5	$1,680	**$3,192**

REGARDING T8 OPTIONS IN PREVIOUS GARAGE TABLE

- Although numerous retrofitters and energy efficient consultants recommend replacing existing MH and HPS fixtures with strait 4’ or 8’ T8 fixtures, because of lower cost, often that does not provide enough light away from ends of fixtures
- Often triangular or T shaped T8 fixtures are much better than straight T8 fixtures

TYPICAL OFFICE 12' long x 10' wide x 9' high

$0.150	KWH rate			$0.05	/KWH 1st year saved rebate	15	years of long term benefit								
existing				proposed											
fixture & application type	total watts	annual hours	annual electrical cost	option letter	retrofit/replacement option description	total watts	watts redux	annual electrical savings	appr. incentive	appr. installed cost	rated lamp life @ 3 hour cycles	payback just electricity	payback including maint-enance savings & worker product-ifity benefits	long term benefit just electricity	**long term benefit including maint-enance savings & worker product-ivity benefits**
12 x 10 x 9 individual office with 2 2x4 18 cell parabolic troffers, each with 3 32W 700 series 20,000 hour rated F32T8s and generic .88 BF ballasting	182	2500	$68.25	A	Retrofit each troffer with ALP RDI AC HT kit, 2 high lumen F32T8 5000K lamps & .77 BF extra efficient instant start ballast	96	86	$32.25	$10.75	$220	24,000	6.5	4.5	$275	**$565**
				B	Retrofit each troffer with ALP RDI AC HT kit, 1 high lumen F32T8 5000K lamp & 1.00 BF extra efficient instant start ballast. Also include LED task light system.	83	99	$37.13	$12.38	$450	24,000 for T8s	11.8	8.3	$119	**$453**
				C	Remove both troffers. Install 8' suspended direct/indirect fixture that has 2 high lumen F32T8 5000K lamps & 1.18 BF extra efficient instant start ballast.	73	109	$40.88	$13.63	$450	24,000 for T8s	10.7	6.4	$177	**$545**
				D	Remove both troffers. Install 8' suspended direct/indirect fixture that has 2 high lumen F32T8 5000K lamps & .87 BF extra efficient instant start ballast. Also include LED task light system.	67	115	$43.13	$14.38	$680	24,000 for T8s	15.4	9.3	-$19	**$628**
				E	Remove both troffers. Install 2 2x2 LED 40W panels (less light than T8 options)	80	102	$38.25	$12.75	$800	50,000	20.6	12.3	-$214	**$131**

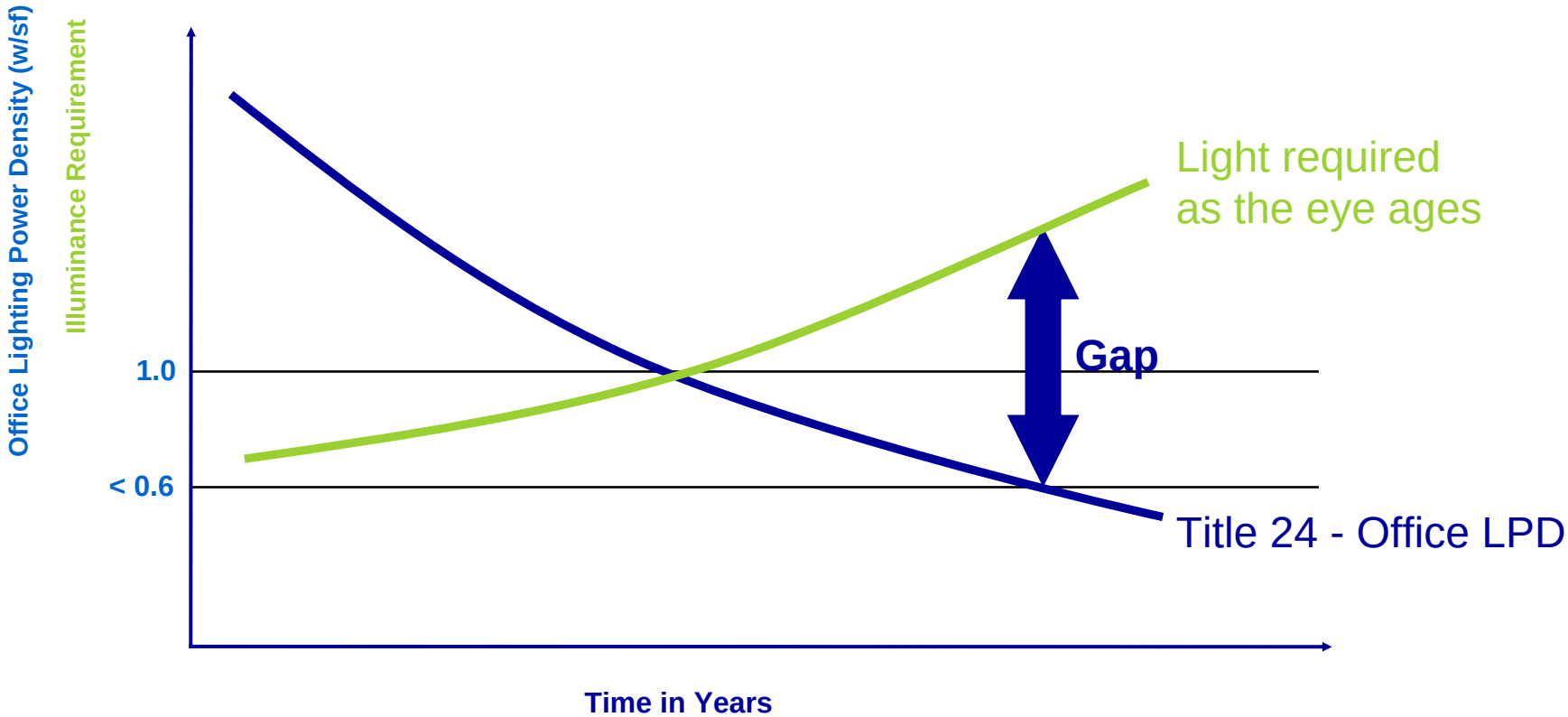
AMBIENT OFFICE LIGHTING

- Of all potential cost effective applications for LEDs, office ambient lighting may be one of the last ones
- In previous table T8 lamp life could be substantially increased with program start ballasts and/or extra long life lamps
- Suspended direct/indirect T8 fixtures would be much more cost effective for new construction and gut rehabs

TASK AMBIENT LIGHTING

- The combination of high performance suspended direct/indirect fixtures with extra efficient fixed BF ballasts and good LED task lights may be the best office lighting solution
  - Much better than dealing with very expensive dimming fluorescent ballasts and control systems
- Finelite is one manufacturer that has focused on it with suspended ambient fluorescent fixtures and PLS (Personal Lighting System) LED task lights
  - www.finelite
- You can also visit www.cltc.ucdavis.edu
  - Projects Research IOLS-PLS

AS POWER DENSITIES DECREASE WORKER AGES INCREASE



Courtesy of Finelite

ADDITIONAL LED INFO

- LEDs Magazine
  - Free electronically
  - www.ledsmagazine.com
- Kevin Dowling's fall of 2007 seminar at the Pacific Energy Center in San Francisco
  - www.colorkinetics.com/corp/events/seminars
- Lighting For Tomorrow's best LED fixture winners
  - www.lightingfortomorrow.com
- LD+A Magazine, especially December 2007
  - 'Testing 1,2' about exterior testing in Oakland and Atlantic City
  - 'Lighting People Are From Mars, LED Folks Are From Venus'
  - And others
  - www.iesna.org
- Beta Lighting website, which has a very good ppt about good LED fixture design in general
  - www.betaled.com
- I will present 4 hour long 'Are LEDs Ready For Prime Time?' numerous times later this year

THAT'S ALL FOLKS

- **For further information**
  - **Stan Walerczyk**
    - **925-944-9481 (San Francisco area)**
    - **stan@lightingwizards.com**
    - **www.lightingwizards.com**
- **Thanks for attending**