Webinar Co-coordinator
Holli.Kuykendall@gnb.usda.gov

Today's presentation will start momentarily.
Press *1 from your telephone handset or toggle the raised hand on/off for Operator Assistance.

Use Notes addressed to "All Moderators" to ask questions during the presentation.

Presented in partnership
USDA NRCS National Energy Team
and East National Technology Support Center

2014 Energy Conservation Opportunities Webinar Series

Webinar Co-coordinator
"Kip" Kenneth.Pheil@por.usda.gov

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Date	Webinar Topics
Mar 20	Key NRCS Practices: Farmstead Energy, Lighting, and Building Envelope
May 22	**Lighting Systems: Analysis, Performance, and Energy Conservation Opportunities**
Jul 24	Energy Analysis: Who, What, When, Where, Why, and How?
Sep 18	Energy Upgrades: Steps to Implement Energy Conservation Opportunities
Nov 20	Poultry Operations: Broiler and Layer Energy Conservation Opportunities

Handouts: See Related Files and Related URLs on the Webinar's Web page at ConservationWebinars.net

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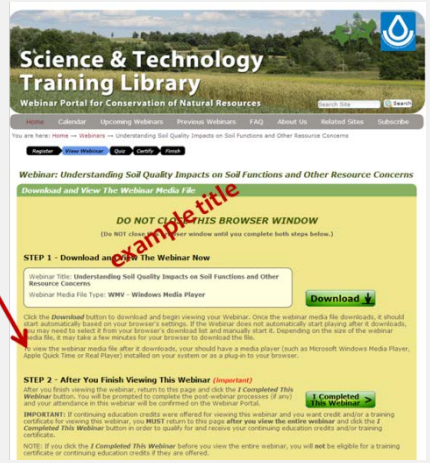
The ENTSC submits Professional CEUs the first of the month on your behalf (CCA, SAF, AFGC, TWS, ARPAS, and/or SRM), but not for Conservation Planner or other state-specific certification programs



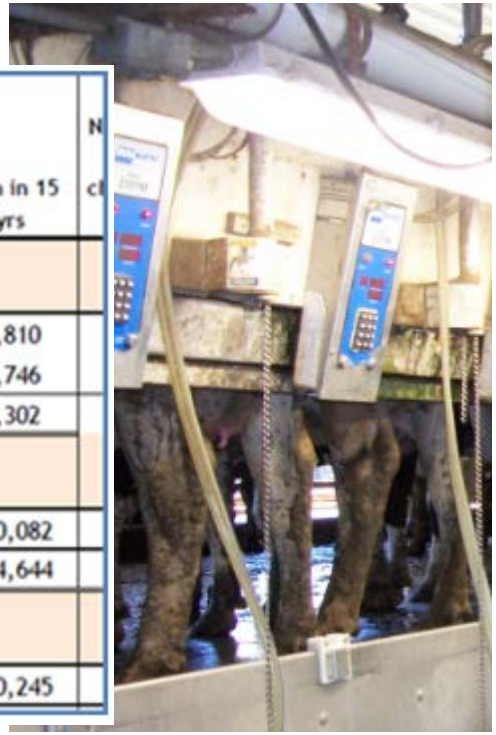
Join information for our webinars is made available at the Science and Technology Training Library at ConservationWebinars.net. The webinar portal at ConservationWebinars.net is provided in partnership with Southern Regional Extension Forestry.

SREF

What's this E doing in my SWAPA? (Energy Conservation Opportunities)

Lighting Systems: Analysis, Performance, and ECOs

System Input Watts per Luminaire	System Luminous Efficacy, lumens per watt	Lamp life @ 10-12 hr starts	Weekly Hours of Operation: Annual kWh	Hours of Operation/15 yrs	kWh in 15 yrs	N cl
			40			
58	98	30,000	121	31,200	1,810	
88	98	30,000	183	31,200	2,746	
50.5	69	50,000	420	31,200	6,302	
			70			
458	92	20,000	20,005	54,600	300,082	
286.5	78	50,000	15,643	54,600	234,644	
			168			
458	92	20,000	60,016	131,040	900,245	



22 May 2014 – second in a series

LIGHTING SYSTEMS ANALYSIS, CONSERVATION, AND ECOs

A four act play

22 May, 2014

Dan Ciolkosz, Penn State Extension, Department of Agricultural and Biological Engineering

Kip Pheil, USDA NRCS National Energy Team

Penn State **Extension**

Who are you listening to?

- Research Associate for Penn State Extension
  - Bioenergy
  - Energy Efficiency
- Ph.D. Agricultural and Biological Engineering
- Professional Engineer

4 “Acts”:

- Lighting Systems and their Design
- Lighting Impacts on Plants and Animals
- Dealing With Existing Facilities
- The Joy of Standards

But first, a commercial or two…

www.energy.extension.psu.edu

PENNSTATE College of Agricultural Sciences

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Renewable and Alternative Energy

- What is Renewable Energy?
- Biofuels
- Energy Use and Efficiency
- Field Crops for Energy
- Wood Energy
- Waste to Energy
- Wind Energy
- Solar Energy
- Renewable and Alternative Energy Team Directory

Learn More...

- Courses and Workshops
- Upcoming Events
- News

Extension Renewable and Alternative Energy Team

About this site

What is Renewable Energy?

Renewable energy is energy generated from natural resources—such as sunlight, wind, rain, tides and geothermal heat—which are renewable (naturally replenished). Renewable energy technologies range from solar power, wind power, hydroelectricity/micro hydro, biomass and biofuels for transportation.

Penn State Extension Energy Programs

Extension educators and faculty are working on many fronts to evaluate energy alternatives, develop strategies for using energy more efficiently and to educate youth, citizens, farmers and policy makers about the complex

Spotlight

- Alternative Energy Credits Program
- Fundraising Request Form
- NEWBio Bioenergy Consortium
- Renewable & Alternative Energy Fact Sheets
- Renewable Energy Academy

ASAE EP344.4 JAN2014
Lighting Systems for Agricultural Facilities

American Society of
Agricultural and Biological Engineers

Act 1: Lighting Systems and Their Design

But, soft! what light through yonder window breaks? It is the east, and Juliet is the sun

- William Shakespeare

Lighting terminology

- **Lumen** = the rate of light emitted by one candle that falls on one square meter (foot) of surface located one meter (foot) from the candle.
- **Illuminance** – light level reaching a surface
  - **FC** = foot candle = lumen per square foot
  - **Lux** = lumen per square meter
- **Coefficient of utilization** = percent of lumen output that reaches the work plane
- **Work plane** = location where “visual work” is done and illuminance level measured
- **Color rendering index** (CRI) = the ability of the light to show colort with incandescent being 100. Lower values indicate poorer color rendering

Light Sources ("Lamps")

Lamp Type	Efficicacy (Lm/Watt)	Color Rendering Index	Rated Life (hours)
Incandescent	12-20	100	750-2000
Halogen	18-25	100	2000-3000
Fluorescent, T12	60-71	60-80	12,000-20,000
Fluorescent, T8	84-94	78-86	15,000-20,000
Fluorescent, compact	50-79	82	10,000-20,000
White LED	50-100	65-85	25,000-75,000
Metal Halide, standard	82-90	65-75	12,000-20,000
Metal Halide, pulse start	92-106	65-70	15,000-30,000
High Pressure Sodium	95-125	20	24,000

Fixtures (“Luminaires”)

COOPER LIGHTING - LUMARK®

DESCRIPTION

The Enterprise 22 industrial low-bay luminaire combines a round, faceted reflector with an injection-molded lens to provide an efficient, symmetrical beam pattern. U.L. listed and labeled for damp location. CSA Certified. The Enterprise 22 combines durable construction with precise optics for mounting heights below 20'. Perfect for warehouses, foundries, gyms, assembly areas, food processing plants and hangars.

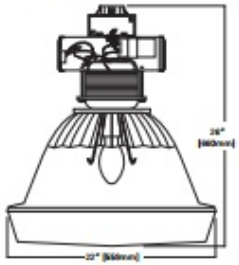
SPECIFICATION FEATURES

Construction
HOUSING: Heavy-duty, formed steel housing with an open air ballast for cooler operation is finished in a white polyester powder coat.

Electrical
BALLAST: High power factor ballast with class H insulation. Minimum starting temperature is -40°C (-40°F) for HPS and -30°C (-20°F) for MH. SOCKET: Mogul-base porcelain socket standard for HPS. For Metal Halide, pulse-start standard, for use with "O" (Open) rated protected Metal Halide lamps only.

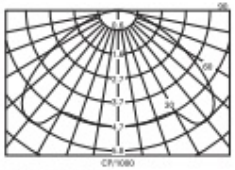
Optical
SEALED OPTICS: Enclosed and gasketed optics seal out dirt and other contaminants. REFLECTOR: Computer designed, faceted reflector provides maximum photometric performance. HANDS-FREE RELAMPING: Trunk latches secure the reflector to the housing, allowing

DIMENSIONS



COOPER Lighting
www.cooperlighting.com

PHOTOMETRICS



HPEP-R22-250-MT-Q
250-Watt HPS
27,500-Lumen Clear Lamp

Coefficients Of Utilization
Effective floor cavity reflectance

RCR	80/50			70		50
rw	70	50	30	10	70	50
1	78	72	69	67	73	70
2	69	64	60	58	65	62
3	62	56	51	48	57	55
4	55	50	44	40	50	48
5	50	44	39	34	45	43
6	45	39	33	29	41	38
7	41	35	29	25	37	34
8	37	31	25	21	33	30
9	34	28	22	18	30	27
10	31	25	19	15	27	24

Spacing Criteria 1.7

Zone	%Lamp	Zone	%Lamp
0-30	14.6	0-90	67.9
0-60	27.7	90-180	1.3
0-90	68.1	Total	69.2

EP

ORDERING INFORMATION

ENTERPRISE 22

Sample Number: MPEP-R22-250-MT-Q

Lamp Type
MP= Pulse Start Metal Halide[1]
MH=Metal Halide[1, 2]
HP=High Pressure Sodium

Series
EP= Enterprise

Reflector Diameter
R22=22" Reflector Diameter

Reflector Type
_=Acrylic
PL=Polycarbonate[3]

Lamp Wattage
MP
100=100W
175=175W
250=250W
320=320W
400=400W
MH [2]
175= 175W
250= 250W
400= 400W
HP
100= 100W
250= 250W
400= 400W

Voltage [4]
120V=120V
208V=208V
240V=240V
277V=277V
347V=347V
480V=480V
MT= Multi-Tap, [5] wired 277V
TT= Triple-Tap, [6] wired 347V
5T= 5-Tap[7]

Socket
OR= Open Rated[8] Socket for Metal Halide Lamps
_= Non Applicable (HPS or Not compatible with OR Socket)

Options
C3=3' Cord with no plug (Specify Voltage)[9]
PC3=3' Cord with NEMA Plug (120V-L5-15P, 208V-L6-15P, 347V-L37-20P, AND 480V-L8-20P) Other cord lengths are available by specifying length (PC6 for 6' Cord) Requires FH-1 or FL-1, or SHK. Example: PC3-120V Use with TPPH-NEMA. Specify Voltage. [9]
PHC= Power Cord and Plug (18" Power Cord and Non-NEMA plug configuration. Must be used with FL-1 and TPPH (Thru-Way Pendant Power Hook). Must specify single voltage.
PHC-NEMA= Power Cord and NEMA Plug (18" Power Cord and 20 AMP NEMA plug configuration). Must be used with FL-1 and TPPH-NEMA (Thru-Way Pendant Power Hook).
FH-1= Die-cast Aluminum Fixture Hook (with 3/4" threads for easy installation)
FL-1= Malleable Iron Plated Fixture Loop (with 3/4" threads for easy installation)
SHK= Die-cast Aluminum Fixture Hook (with safety screw and 3/4" threads for easy installation)
SS= Space Saver Feature
F1=Single Fuse (120, 277 or 347V only)
F2=Double Fuse (208, 240 or 480V only)
SCF=3' Aircraft Safety Cable secures Housing to Ceiling (Alternative lengths available. Example: SCF6 = 6' Cable)
Q=Quartz Restrike (Hot Strike Only)
EM=Quartz Restrike with "Delay Relay" (Quartz lamp strikes at both hot and cold starts)
EM/SC=Emergency Separate Circuit[10]
L/TCB=Less Top Connector Box (Housing shipped less top connector box. (Specify when using TWMBS accessory)
LL=Lamp Included[11]
CEC=California Title 20 Compliant Ballast (Applies to 250-320W and 400-450W MP only)
SCR=Aircraft Safety Cable-Housing to Reflector
WMWS=MWS Industrial components attached to the fixture at the factory. (Standard cord length is 3 ft, 6 ft. and 11 ft. also available. Please refer to MWS Modular Wiring System section for additional information.
HC=LumaWatt Fixture Control Module [12, 13] (Low voltage leads pulled out of top connection box for areas requiring all wiring to be installed in conduit)
HL=LumaWatt Fixture Control Module [13] (Allows low voltage control wire to be daisy-chained between fixtures outside AC conduit run similar to low voltage intercom's, fire alarms and phone systems)
OLL=Quartz Lamp Included (Lamp is Cooper designated product based on luminaire requirements. Lamp is shipped separate from luminaire unless otherwise noted)
FILT= Sintered Bronze filter (Sintered bronze filter prevents the entrance of contaminants)

Accessories [14]
C3=3' Cord-No Plug - Requires FH-1, FL-1, or SHK
PC3=3' Cord with NEMA Plug - (120V-L5, 208V-L6-15P, 347V-L37-20P and 480V-L8-20P) Other cord lengths are available by specifying length (PC6 for 6' cord). Requires FH-1 or FL-1, or SHK. Use with TPPH-NEMA. Specify Voltage.
PHC= Power Hook Cord and Non-NEMA plug configuration. Must be used with FL-1 and TPPH (Thru-Way Pendant Power Hook)
PHC-NEMA= Power Cord and NEMA plug - 18" Power Cord and 20 Amp NEMA plug configuration. Must be used with FL-1 and TPPH-NEMA (Thru-Way Pendant Power Hook)
WG22/EP= Wire Guard
MBT= Twin Mount Bracket (Fixtures must be same voltage and without hooks, loops or plugs.)
TPPH= Thru-Way Pendant Power Hook. Requires FL-1 and PHC. Specify Voltage.
TPPH-F= Thru-Way Pendant Power Hook Single Fuse, 120, 277 or 347 Volt. Requires FL-1 and PHC. Specify Voltage.
TPPH-F2= Thru-Way Pendant Power Hook - Double Fused, 208, 240, or 480 Volt. Requires FL-1 and PHC. Specify Voltage.
TPPH-F-QD= Thru-Way Pendant Power Hook Single Fuse, Quick Disconnect. Requires FL-1 and PHC. Specify Voltage (120, 277, or 347V)
TPPH-F2-QD=Thru-Way Pendant Power Hook Double Fuse, Quick Disconnect. Requires FL-1 and PHC. Specify Voltage (208, 240, or 480V)
TPPH-NEMA= Thru-Way Pendant Power Hook. Requires FL-1 and PHC-XXXV-NEMA. (Specify
FH-1=Fixture Hook
FL-1=Fixture Loop
SHK=Hook with Safety Screw
TWMBS=Thru-Way Mounting Box [15]

Notes:
1. Open Rated socket and lamp must be used.
2. MH available in non-U.S. markets only.
3. Not recommended for use with Metal Halide lamps due to rapid yellowing typical of polycarbonate material.
4. Products also available in non-US voltages and 50HZ for international markets. Consult your Cooper Representative for availability and ordering information. 80% Efficient EISA Compliant MP Fixtures not available in 347V and TT Voltages.
5. Multi-Tap ballast 120/208/240/277V wired 277V.
6. Triple-Tap ballast 120/277/347V wired 347V.
7. 5-Tap ballast 120/208/240/277/480V wired 277V. 400W Metal Halide only. 88% efficient EISA Compliant MP fixtures not available in 5-Tap Voltages.
8. Not applicable for HPS.
9. Requires FH-1or FL-1or SHK.
10. Not available with HL or HC options.
11. Lamp is shipped separately.
12. Not available with PC3, C3, PHC or MWS. Not available with single circuit MWS special order.
13. 30 second time delay when switching from bright to dim. Consult individual lamp manufacturers recommendations for compatible lamps. For use with CWA ballast only.
14. Order separately.
15. Specify L/TCB when using thru-way mounting box (TWMBS) accessory.

LAMP TYPE	WATTAGE
Pulse Start Metal Halide (MP)	70, 100, 175, 200, 250, 320, 350, 400, 450W
Metal Halide (MH)	175, 250, 400W
High Pressure Sodium (HP)	70, 100, 150, 250, 400W

VOLTAGE CHART	
MT= Multi-Tap	120/208/240/277V (wired 277V)
TT= Triple-Tap	120/277/347V (wired 347V)
5T= 5-Tap [8]	120/208/240/277/480V (wired 277V)

STOCK SAMPLE NUMBER

Stock Sample #: FS25-NL

F		
Series F=Enterprise	Lamp Type S=High Pressure Sodium M=Metal Halide P=Pulse Start Metal Halide	Lamp Wattage 25=250W 32=320W 35=350W 40=400W 40Q=400W and Quartz Restrike 25B=250W (Canada, Triple-Tap Ballast) 40B=400W (Canada, Triple-Tap Ballast)

NOTES:
Options not available with stock products. Order Accessories as separate items for field installation. Refer to standard ordering information to add options and accessories.

COOPER Lighting
www.cooperlighting.com

NOTE: Specifications and dimensions subject to change without notice.
Visit our web site at www.cooperlighting.com
Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770.486.4801

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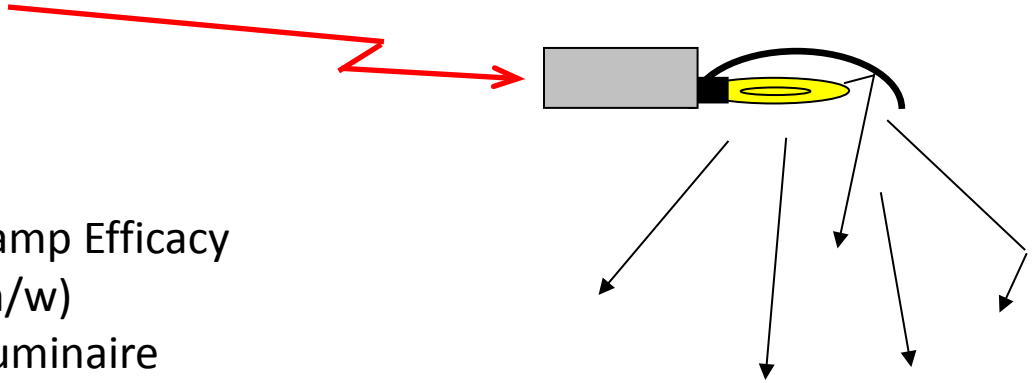
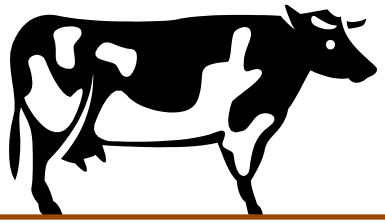
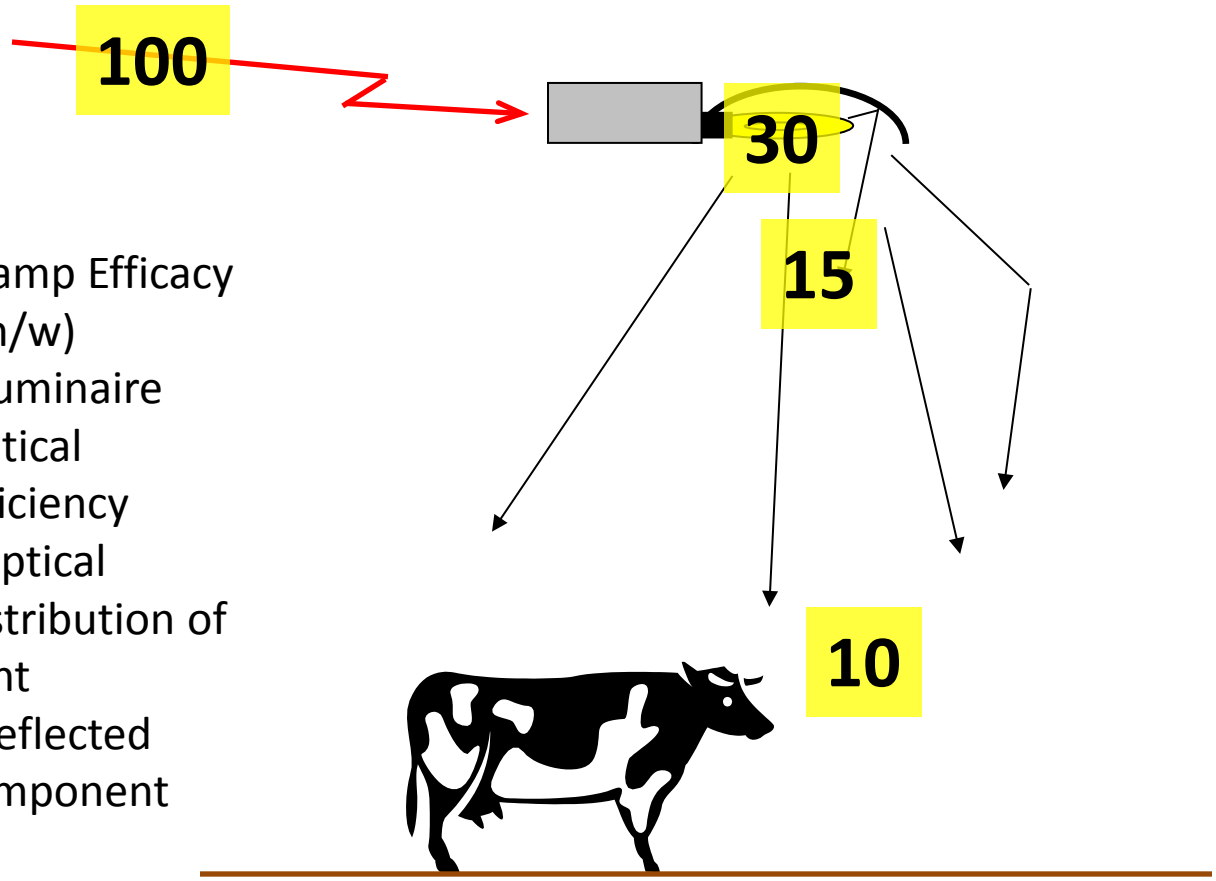
High Efficiency Lighting Systems?



- Lamp Efficacy (lm/w)
- Luminaire Optical Efficiency
- Optical Distribution of light
- Reflected component



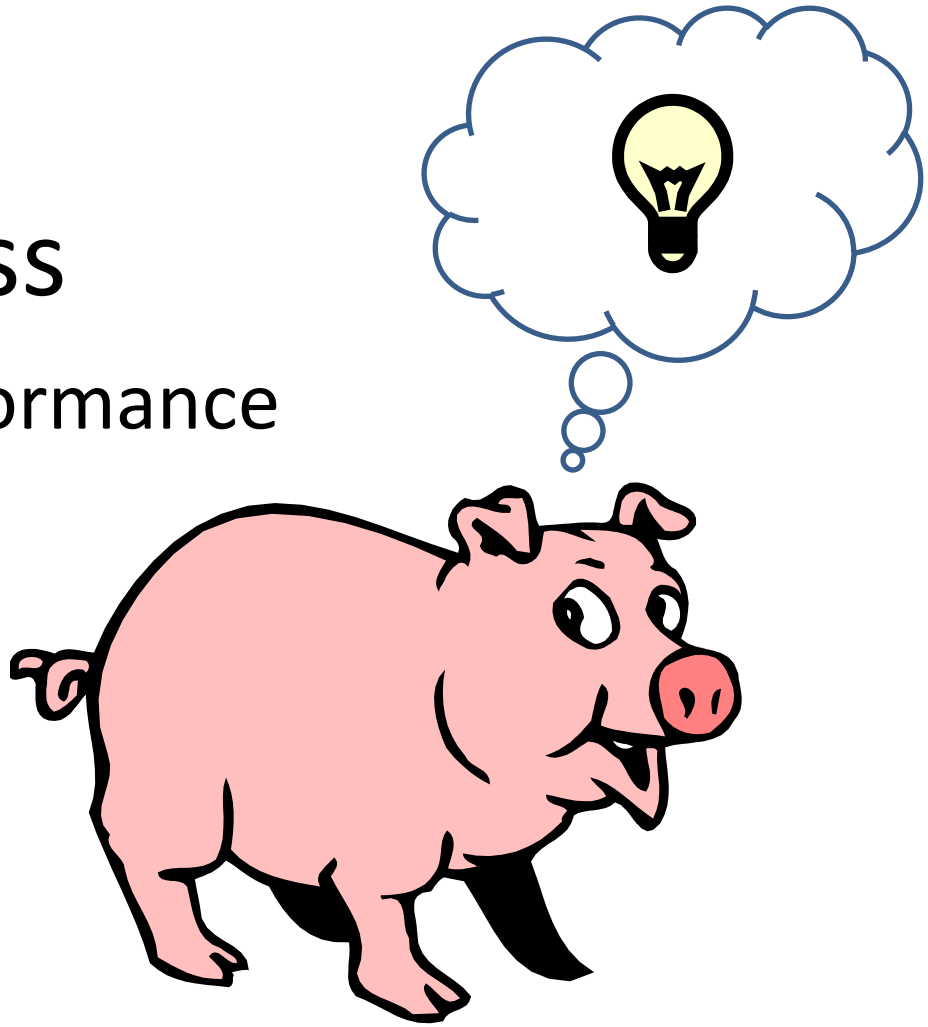
High Efficiency Lighting Systems?



- Lamp Efficacy (lm/w)
- Luminaire Optical Efficiency
- Optical Distribution of light
- Reflected component

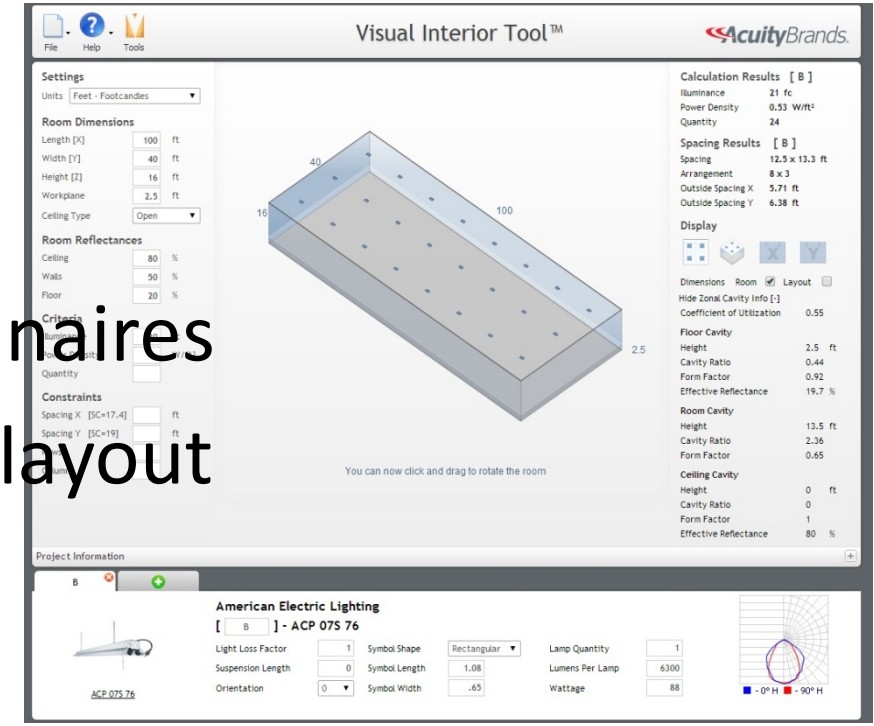
The Design Process

1. Establish target performance
   - Average illuminance
   - Allowable uniformity
   - Color rendering
   - Glare
   - Operating conditions
   - Switching/control requirements



The Design Process

2. Select Lamps and Luminaires
3. Calculate number and layout
   - Zonal Cavity method
   - Point Calculations
   - Computer Simulation – flux transfer and ray tracing
4. Lay out electrical distribution and controls



Design Approaches – General Lighting

Design Approaches – Task Lighting


General Lighting? Task Lighting?

Intensive lighting areas

- Milking parlor, Equipment washing area, Equipment maintenance, Maternity and veterinary care areas
- Seeding and Transplanting, Growth Rooms, Lighting for Photosynthesis

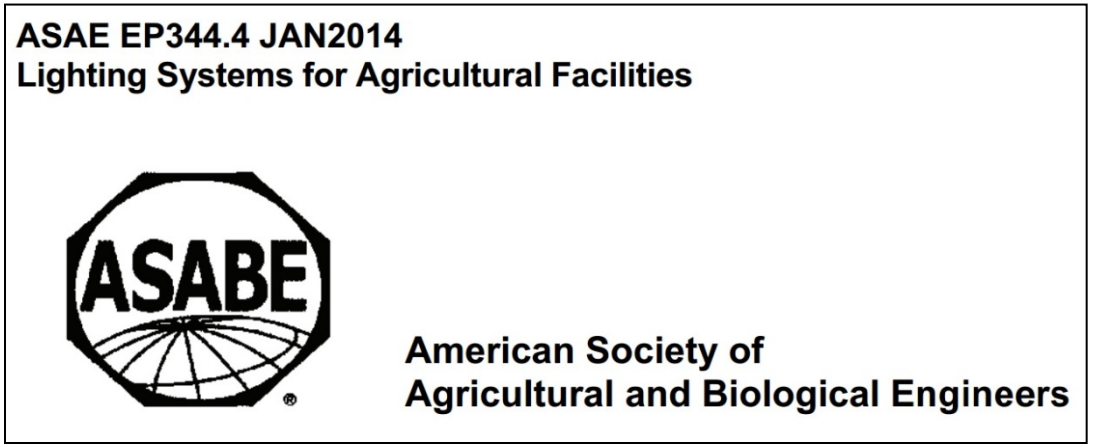
Moderate and low lighting areas

- Moderate
  - Holding pens, Feeding areas, Animal sorting and observation areas, General cleanup and repair

- Low lighting areas
  - Stalls, Walkways, Equipment Storage
  - Refrigerated Storage, Lighting for photoperiod control

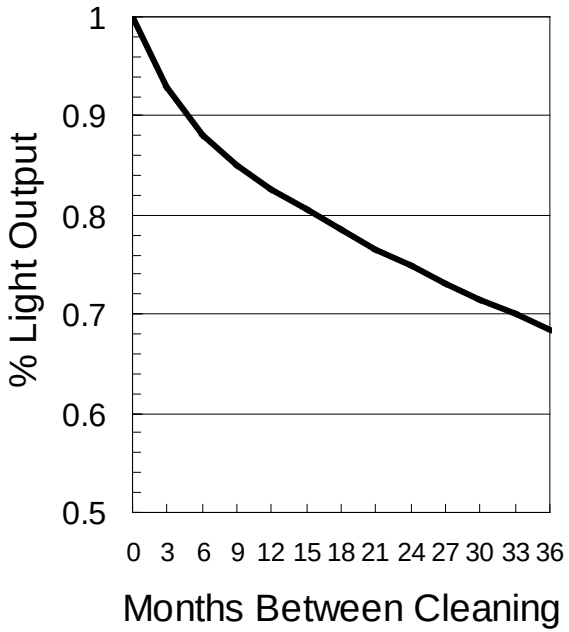
Lighting levels for various areas

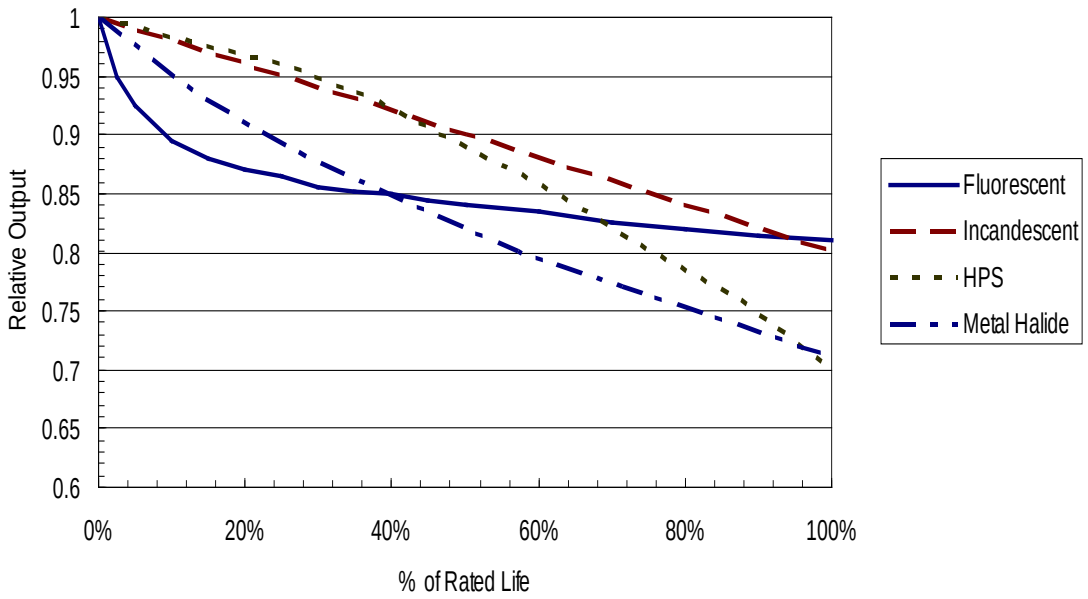
- Check **ASABE EP344.4** – Lighting Systems for Agricultural Facilities for specific recommended illuminance levels for
  - Dairy Production
  - Feed Yards
  - Swine Production
  - Poultry
  - Equine
  - Greenhouse



Design Light Level = Initial Light Level * Light Loss Factor

LLF= BF * LLD * LDD * RSDD





Luminaire Environment

- “Dry”
- “Damp”
- “Wet”
- Also dust, corrosive vapors

- “IP” (ingress protection) ratings internationally

Wiring for Agricultural Lighting

- “All work areas should be equipped with light switches at each principle entrance.”
- Install switches on the latch side of the entrance, or the right side when entering (if no door).
- Mount switches 1.2m (48”) above the floor, or up to 1.8m (72”) in buildings housing livestock

Agricultural Wiring Handbook, 15th ed.

Wiring for Agricultural Lighting

- “Luminaires shall be designed to minimize the entrance of dust, moisture, and corrosive material.”
- “Luminaires exposed to physical damage shall be protected by a suitable guard.”
- “Luminaires exposed to water from condensation, building cleansing water, or solution shall be watertight.”

NEC Article 547 – Agricultural Buildings

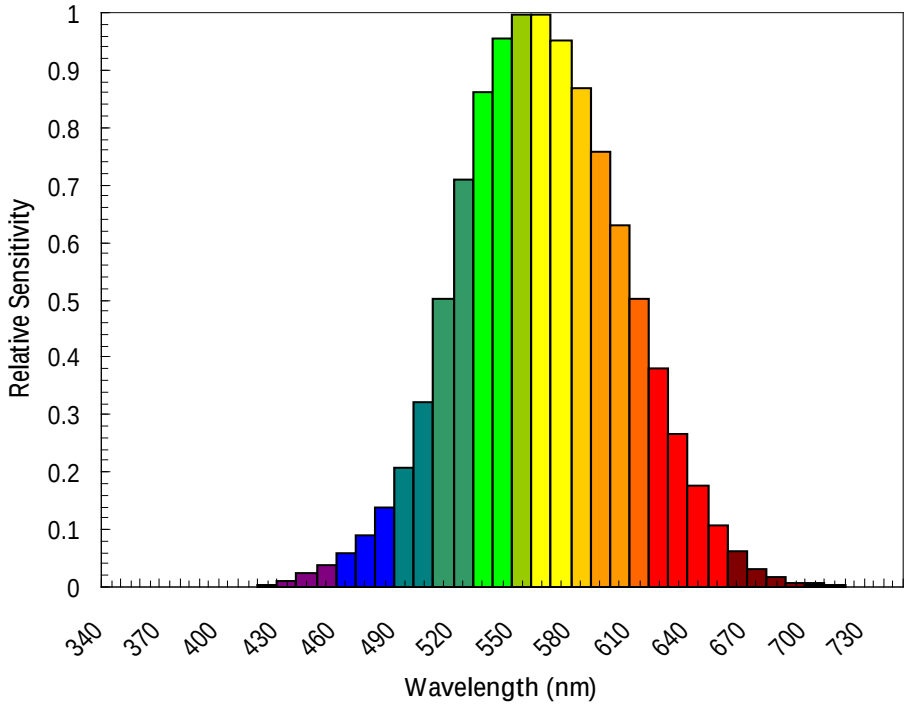
Act 2: Animal and Plant Responses to Lighting

Truly the light is sweet, and a pleasant thing it is for the eyes to behold the sun

- Ecclesiastes 11:7

Human Responses - Visibility

- Illuminance
- Contrast
- Glare



Other Human Responses

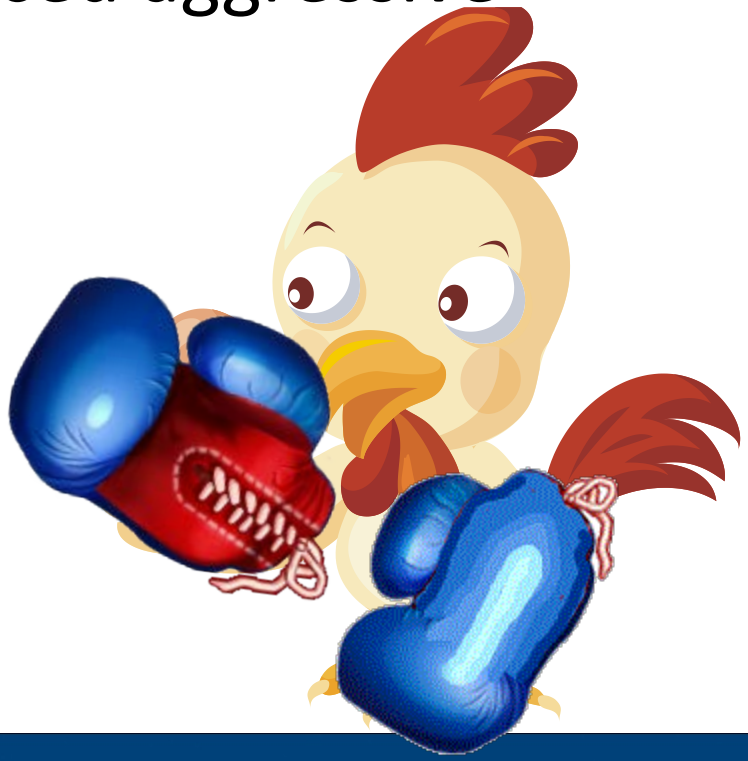
- Physiological responses
  - Seasonal Affective Disorder (SAD)
- Psychological responses
  - Can convey impressions of spaciousness, relaxation, attention, privacy, etc.

Animal Responses - Visibility

- Similar wavelength-specific sensitivity
- Acuity (sharpness of vision) can vary widely

Animal Responses - Behavior

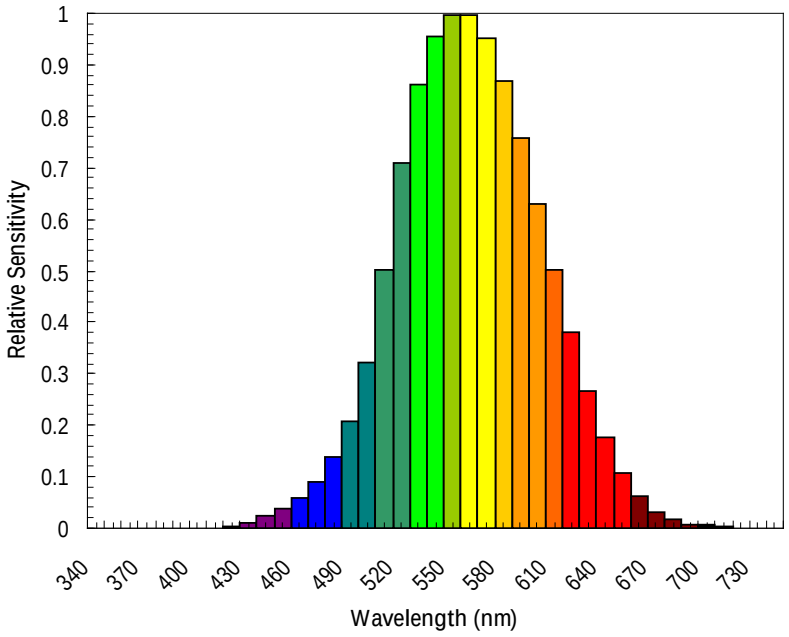
- High illuminance – increased feed rates
- Low illuminance – reduced aggressive behavior

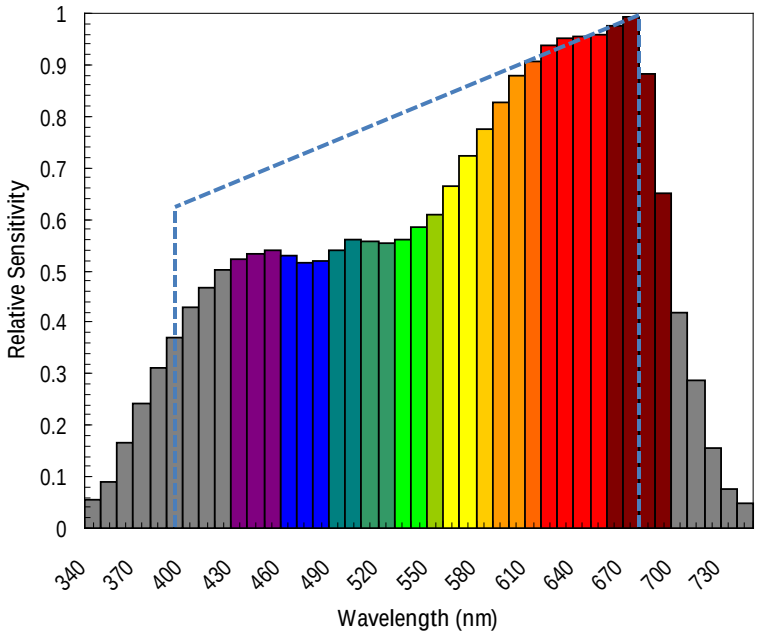


Animal Responses - Reproductive

- “Long day lighting” during winter can enhance milk production in dairy cows (150 lux, 16-18 hrs d^{-1})
- Similar impacts with swine, horses, etc.

Plant responses - Photosynthesis





Lux = lumens m^{-2}

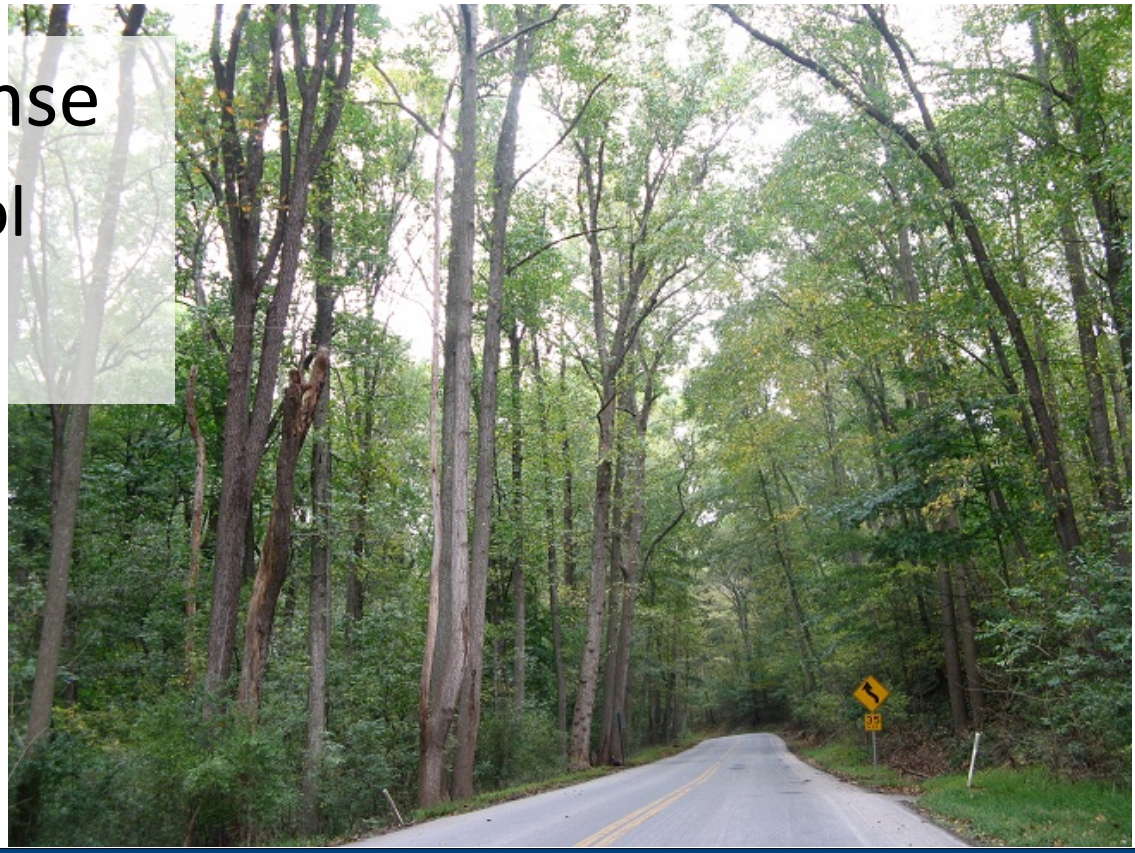
PAR = umol m^{-2} s^{-1}

Plant Responses Photoperiodism

- Phytochrome-mediated effect
- Daylength/night length
  - Control of flowering
- Red:Far Red Ratio
  - Impacts internode length - stretching

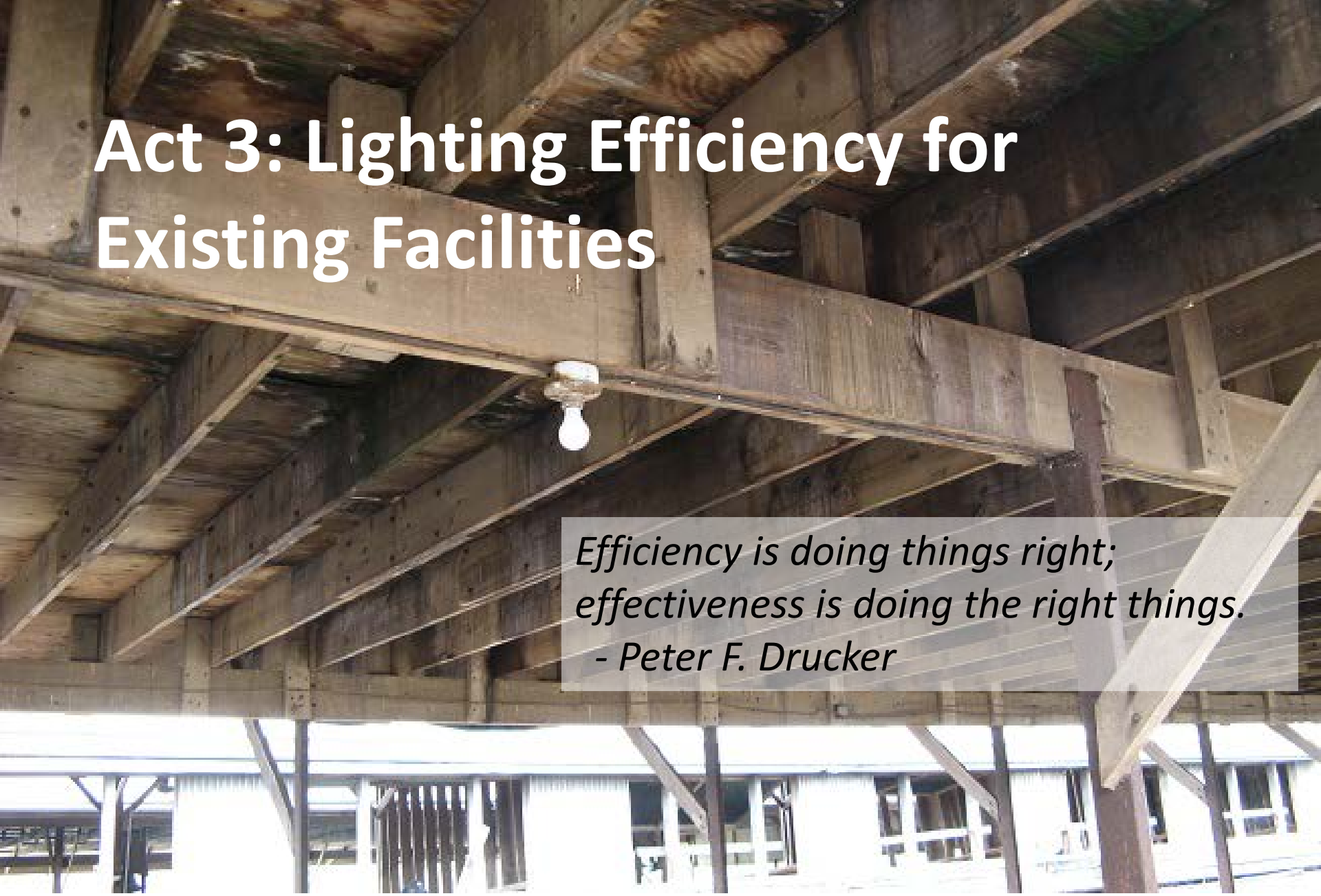
Plant Responses – Other Morphogenic Effects

- Blue light response
  - Stomatal control
  - Plant form




Intermission:
Q&A

Act 3: Lighting Efficiency for Existing Facilities



Efficiency is doing things right; effectiveness is doing the right things.
- Peter F. Drucker

Types of light sources

Lamp Type	Efficicacy (Lm/Watt)	Color Rendering Index	Rated Life (hours)
Incandescent	12-20	100	750-2000
Halogen	18-25	100	2000-3000
Fluorescent, T12	60-71	60-80	12,000-20,000
Fluorescent, T8	84-94	78-86	15,000-20,000
Fluorescent, compact	50-79	82	10,000-20,000
White LED	50-100	65-85	25,000-75,000
Metal Halide, standard	82-90	65-75	12,000-20,000
Metal Halide, pulse start	92-106	65-70	15,000-30,000
High Pressure Sodium	95-125	20	24,000

Lighting suggestions

- Switch from Incandescent to compact fluorescent or LED
  - Simple, low cost measure
  - Need to consider how to keep the light sources clean
- Switch from T12 fluorescent to T8 or T5 fluorescent
  - Good for office and other interior spaces
  - Efficient and good color rendering

Lighting suggestions

- Switch from incandescent or fluorescent to Metal Halide
  - Good for free stall barns, greenhouses
  - Need high mounting height
  - Good color rendering
  - Pulse start extends life
- Switch from Mercury Vapor or Metal Halide to High Pressure Sodium
  - Very efficient
  - Low color rendering (yellow light)

SPECIFICATION FEATURES

Construction
HOUSING: Heavy-duty, formed steel housing with an open air ballast for cooler operation is finished in a white polyester powder coat.

Electrical
BALLAST: High power factor ballast with class H insulation. Minimum starting temperature is -40°C (-40°F) for HPS and -30°C (-20°F) for MH. SOCKET: Mogul-base porcelain socket standard for HPS. For Metal Halide, protected socket standard, for use with "0" (Open) rated protected Metal Halide lamps only.

Optical
SEALED OPTICS: Enclosed and gasketed optics seal out dirt and other contaminants. REFLECTOR: Computer designed, faceted reflector provides maximum photometric performance. HANDS-FREE RELAMPING: Trunk latches secure the reflector to the housing, allowing toolless entry, while internal hangers hold reflector/refractor for hands-free relamping. LENS: 100% virgin UV stabilized acrylic refractor.

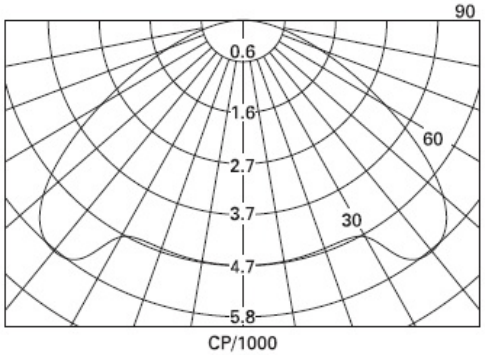
Mounting
Easy slide-on die-cast aluminum mounting box with tapped opening for 3/4" conduit.

EP
ENTERPRISE 22

70 - 450W
High Pressure Sodium
Pulse Start Metal Halide
Metal Halide

Luminaire Efficiency

PHOTOMETRICS



HPEP-R22-250-MT-Q
250-Watt HPS
27,500-Lumen Clear Lamp

Coefficients Of Utilization

Effective floor cavity reflectance	80%				70%				50%			30%		
rc														
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10
RCR														
1	75	72	69	67	73	70	68	65	67	65	63	64	63	61
2	69	64	59	55	67	62	58	55	60	56	53	57	54	52
3	63	56	51	46	61	55	50	46	53	48	45	51	47	44
4	58	50	44	40	56	49	43	39	47	42	39	45	41	38
5	53	44	38	34	51	43	38	33	42	37	33	40	36	32
6	48	39	33	29	47	38	33	28	37	32	28	36	31	28
7	44	35	28	24	43	34	28		33	27	24	32	27	23
8	40	31	25	21	39	30	2		29	24	20	28	24	20
9	37	28	22	18	36	27			26	21	17	25	21	17
10	34	25	19	15	33	24			23	18	15	23	18	15

Spacing Criterion 1.7

Zone	%Lamp	Zone	%La
0-30	14.6	0-90	67.9
0-40	27.3	90-180	1.3
0-60	55.1	Total	69.2

Candlepower

Degree	CP
0	4793
5	4751
10	4695
15	4658
20	4687
25	4800
30	5139
35	5584
40	5757
45	5517
50	4862
55	3840
60	2763
65	1966
70	1388
75	989
80	700
85	454
90	281

maintenance

- Clean reflectors at least 2x per year
- Clean reflective surfaces (walls and ceilings) monthly
- Inspect sockets and reflectors
- Replace lamps before they actually burn out
  - Light output will decrease over time
  - Example: Incandescent will produce 89% of original lumen at 70% of normal life
  - Need to use a light meter to measure output

Penn State **Extension**

Controls

- Occupancy sensors
- Bi-level switching
- Daylighting

Economics of Energy Efficient Lighting

- Energy Savings should offset installation costs
- Hrs/yr of operation a key consideration

$$P(\text{yrs}) = \frac{\$\text{install}}{\frac{\text{hpy} * (W_{old} - W_{new})}{1000} * \$/\text{kwh}}$$

Note: USDA NRCS and RD programs are available to help with installation costs on retrofits

Final Thoughts

- Lighting is not the biggest energy draw on the farm
- but improvements are often economical – a relatively easy upgrade
- The building structure and use of the area will determine the most suitable type of lighting

Selected content originally prepared by Dr. S. Dihn, Penn State Extension

Act 4: Lighting Standards

Barbarism is the absence of standards to which appeal can be made.

- Jose Ortega y Gasset

Act 4: Lighting Standards

Barbarism is the absence of standards to which appeal can be made.

- Jose Ortega y Gasset

That Ultimate Truth is declared as the illuminator of all that illuminates …

- Bhagavad-Gita

All the world's a stage, …

National Energy Technology Development Team ('10-today)
- *Practice Standards*
- *Training*
- *Tools + Documents*
- *Conservation Innovation Grants*

Oregon Dept. of Energy ('89-'10)
Honeywell ('84-'89)
Energy Brokers ('82-'84)
C.E.M., Assoc. of Energy Engineers
BSME, Oregon State Univ. ('78-'83)

Kip Pheil

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Key NRCS Energy Practices:

- Connect NRCS Practice Standards to ASABE S612
  - Farmstead Energy Improvement (374)
  - Building Envelope System Improvement (672)
  - Lighting System Improvement (670)

Act 4 – cast of players

- Performing On-Farm Energy Audits

  ANSI/ASABE S612 (Jul 2009)

- Lighting Systems for Agricultural Facilities

  ASAE EP344.4 (Jan 2014)

- Lighting System Improvement

  CPS 670 (Apr 2013)

Act 4 – cast of players

- Performing On-Farm Energy Audits
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Lighting System … (670)

nrcs conservation prac

Conservation Practices

Alphabetical Index

A-C, D-F, G-I, K-M, N-P, Q-R, S-T, U-Z

Conservation Practice Name (Units) (Code) (Date Issued)	Standard PDF	Standard Word	Info. Sheet/ Practice Overview	CPPE	Job Sheet/ Implement. Require.	National Statement of Work Template	Network Effects Diagram
Lighting System Improvement (670) (4/13)	PDF	DOC		PDF		DOC	PDF

NRCS website

Lighting System … (670)

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Network Effects Diagram (pg 1)

LIGHTING SYSTEM IMPROVEMENT

PRACTICE INTRODUCTION

USDA, Natural Resources Conservation Service—Practice Code 670

System Input Watts per Luminaire	System Luminous Efficacy, lumens per watt	Lamp life @ 10-12 hr starts	Weekly Hours of Operation: Annual kWh	Hours of Operation/15 yrs	kWh in 15 yrs	N cl
			40			
58	98	30,000	121	31,200	1,810	
88	98	30,000	183	31,200	2,746	
50.5	69	50,000	420	31,200	6,302	
			70			

LIGHTING SYSTEM IMPROVEMENT

Lighting System Improvement is applied as part of a conservation management system to reduce

fixtures must be non-corrosive and w
resistant to protect lamps. When auto
controls are used, they must meet the
purpose, be compatible with the light

Network Effects Diagram (pg 1)

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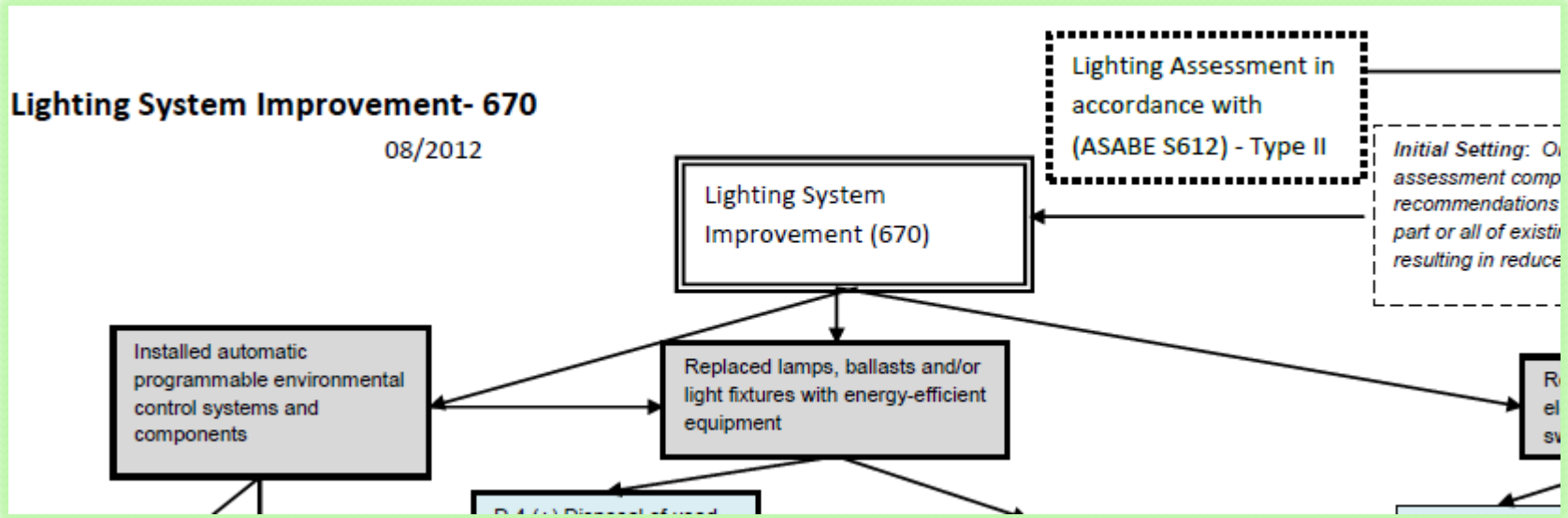
Similar to Practice Overview …

Network Effects Diagram (pg 2)



beyond scope of this webinar …

Lighting System … (670)

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Four linked documents …

Practice Structure, some Rules ..

Component	State Adoption
Name	Cannot modify.
Definition	
Purpose(s)	State may remove, if ...; Can add more (w/ HQ okay).
Condition where CPS Applies	Modify as needed.
Criteria	More stringent, if needed. Can relax (w/ HQ okay).
Consideration(s)	Modify as needed.
Plans & Specifications	
Operation & Maintenance	
References	

Practice Structure

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Operation & Maintenance	
References	

National Standard (670)

NATURAL RESOURCES CONSERVATION SERVICE

CONSERVATION PRACTICE STANDARD

LIGHTING SYSTEM IMPROVEMENT

(No.)

CODE 670

DEFINITION

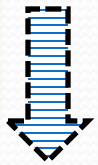
Complete replacement or retrofitting of one or more components of an existing agricultural lighting system.

PURPOSE

This practice may be applied as part of a fire protection standards as well as any local regulations.

Housing, wiring, mounting, and connections shall meet National Electrical Code: Article 547, Agricultural Buildings (NFPA, 2011).

Ensure that the modified lighting system meets



NRCS NHCP

April 2013

State Standard (.pdf)

PA670 - 1

CONSERVATION PRACTICE STANDARD

LIGHTING SYSTEM IMPROVEMENT

(No.)

CODE 670

Pennsylvania April 2014

Conservation (energy or other) an IMBY event.

Nat'l Standard (670)

DEFINITION

Complete replacement or retrofitting of one or more components of an existing agricultural lighting system.

Recall: State cannot change the definition.

Nat'l Standard (670) …

PURPOSE

This practice may be applied as part of a conservation management system to reduce energy use.

… reduce energy use.

State can add a purpose, if approved by National office.
State can delete a purpose if inapplicable.

Nat'l Standard (670) - extract

PURPOSE

This practice may be applied as part of a conservation management system to reduce energy use.

Generally, for NRCS Conservation Planning,

"reduce energy use"

presumes baseline production levels are held.

Nat'l Standard (670) - extract

CONDITIONS WHERE PRACTICE APPLIES

This practice applies to any agricultural facility with an existing lighting system and a completed lighting assessment that complies with the guidelines for a Type 2 on-farm energy audit for the major activity of lighting per ANSI/ASABE S612.

ASABE S612 Type 2 for Major Activity of Lighting

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Flashback

Key NRCS Energy Practices:

- Connect NRCS Practice Standards to ASABE S612
  - Farmstead Energy Improvement (374)
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  - Lighting System Improvement (670)

NRCS Energy Analysis per:

flashback

ANSI/ASABE S612 JUL2009
Performing On-farm Energy Audits

ASABE®

American Society of
Agricultural and Biological Engineers

Energy NCPS - Req'd Analysis

(code) Title	Analysis Threshold
(374) Farmstead Energy * * aka umbrella energy practice standard	ASABE S612, Type 2 • Systems & Eqpt based on Farm Enterprise (Table 1)
(672) Building Envelope	ASABE S612, Type 2 • Heating • Ventilation • Air Cooling
(670) Lighting System	ASABE S612, Type 2 • Lighting

Threshold based on system interactions (or lack of).

Energy NCPS - Req'd Analysis

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NRCS Ag Energy Mngt Plan ~ (374) threshold

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flashforward

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Consideration(s)	Modify as needed.
Plans & Specifications	
Operation & Maintenance	
References	

Nat'l Standard (670) - Criteria

- ASABE S612, Type 2 for Lighting
  - Est. Baseline Use, Lighting (kWh/yr)
  - Est. Energy Benefit (kWh/yr) *
- CRI > 70, if Inspection area (performance)
- > 50 lumen/watt (efficiency metric)
- Use automated controls if warranted (occupancy / daylight)

* aka 'reduced energy use'

Nat'l (670) – Criteria (…)

- Comply w/ certain ASAE EP344.3 items:
  - Light Quality + Levels *
  - Task Uniformity + Ratios *
- Dispose per environmental laws & regulations
- Follow safety protocols (humans & animals)
- Comply with Codes - electrical / fire
- & Etc.

State may adopt more stringent Criteria;

State may seek less restrictive Criteria.

* next, please …

EP344.4 – Quality / Level, e.g.

Table 6 – Recommended illuminance levels for dairy livestock facilities (RERC, 2009; MWPS, 2013; Leech and Person, 1993).

Work Area or Task	Illuminance (lux)
Parlour, pit and near udder	500
Parlour, stalls and return lanes	200
Parlour, holding area	100
Milk room, general	200
Milk room, washing	750–1,000
Dairy housing and feeding area	250

(one of several tables for varied enterprise types)

EP344.4 – Uniformity

Table 3 – Recommended lighting uniformity criteria for agricultural facilities (Chastain et al., 1997 Ciolkosz et al, 2001)

Task Classification	Maximum CV (%)	Typical s/mh
Visually intensive (i.e., milking)	25	0.87
Handling of livestock and equipment	45	1.57
General low-intensity lighting	55	1.92
Greenhouse lighting, research facility	5	0.8
Greenhouse lighting commercial facility	10	1.0
Note: s/mh = luminaire spacing divided by mounting height above workplane		

ASAE EP344.4 JAN2014

Note (R2014 vs R2005):

s/mh replaced s/Hp

CV = coefficient of variation; mh = Mnt Ht; s = spacing

Act 4 – CliffsNotes™

- Remember that States' rule
  - Conservation from the ground up.
- Lighting (670) Criteria include:
  - Analysis per ASABE S612, Type 2 for Lighting
  - Follow Codes (elec / fire / environmental)
  - ≥ 50 lumen/W (all) & CRI ≥ 70 (some areas)
  - Portions of ASABE EP344.4
  - Automated Controls, where appropriate.

Forward (or back)

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Replay or Live. (Search: “nrcs energy conservation opportunity webinar”)

Kip Pheil

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- *kenneth.pheil@por.usda.gov*
- *(503) 310-3037 (m)*

Benefits of Natural Light; Hells Canyon (2010)


The End
Q&A
(appendices follow)

Forward (or back)

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Final Questions?

Note to "All Moderators"

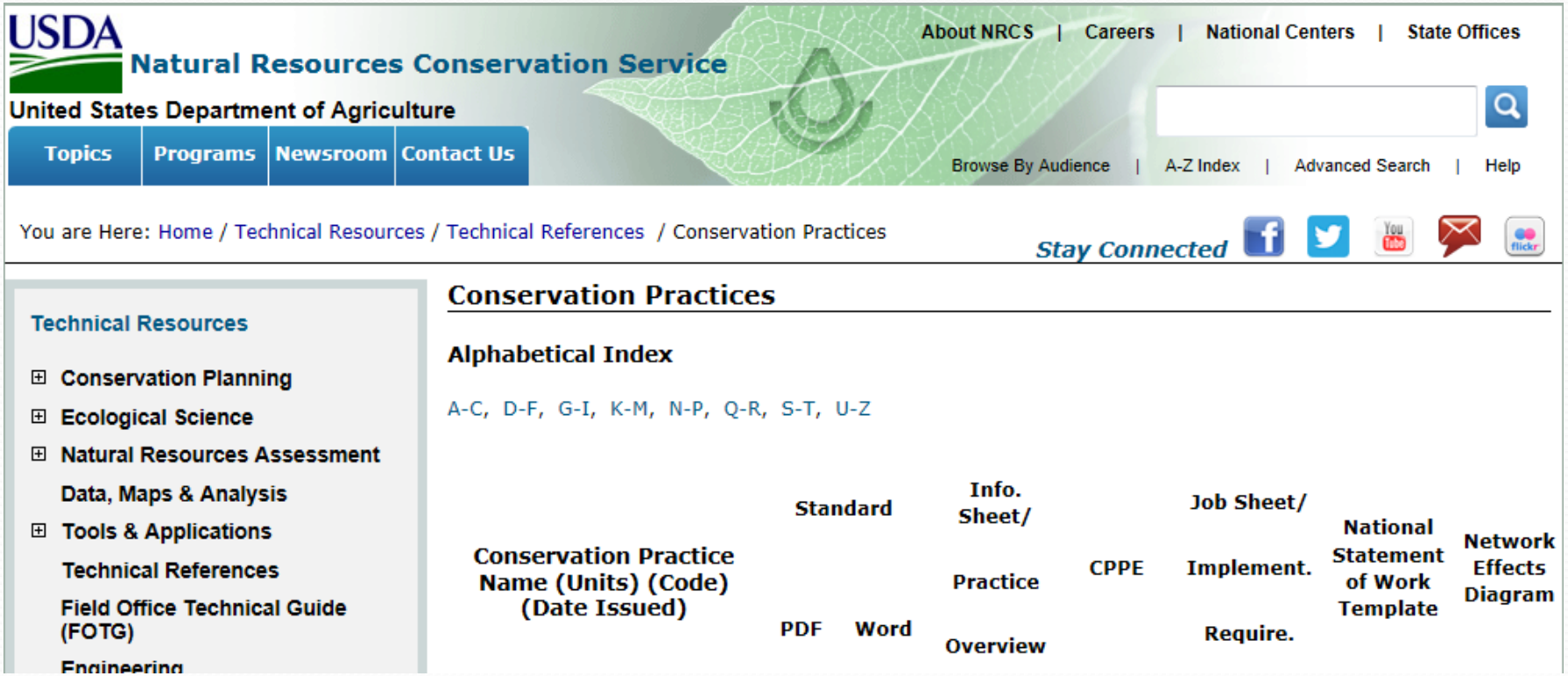
Benefits of Natural Light; Hells Canyon (2010)

Appendices

- Conservation Practice Documents
  - Steps to retrieve (670)
  - CPPE * for (670)
  - Statement of Work for (670)
- How to find a State adopted CPS, e.g. (670)
- ASABE S612 extracts
- Elizabethan Play Structure – Act V

* Conservation Practices Physical Effects

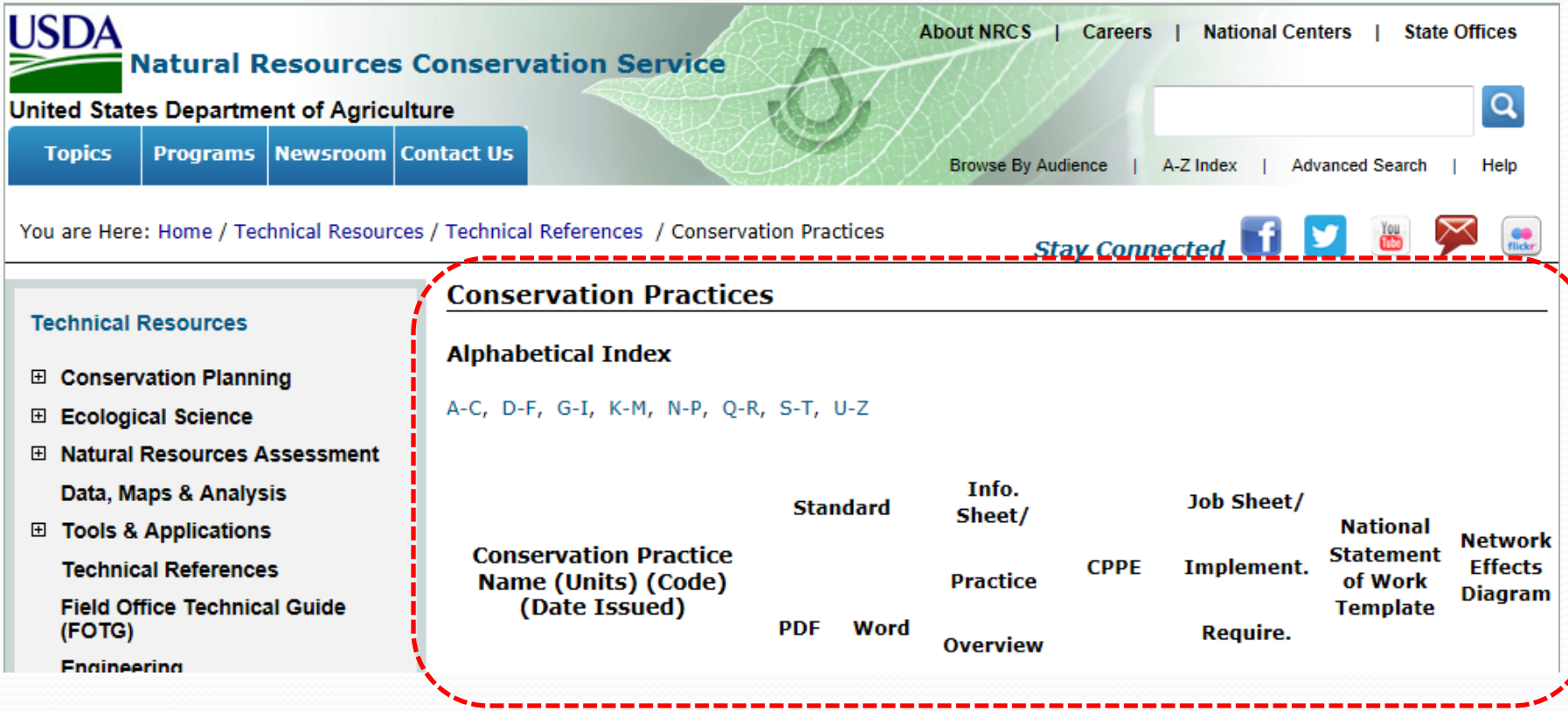
NRCS NCPS [^]



www.nrcs.usda.gov/wps/portal/nrcs/detailfull/national/technical/references/?cid=nrcs143_026849

^ - National Conservation Practice Standard

NRCS NCPS [^]



zoom to this ..

Lighting System … (670)

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Lighting System … (670)

flashback

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Four linked documents …

CPPE [^]

Effects of NRCS Conservation Practices - National

Lighting System Improvement

#N/A

Soil Erosion	*Effect*	*Rationale*
Soil Erosion - Sheet and Rill Erosion	0	Not Applicable
Soil Erosion - Wind Erosion	0	Not Applicable

CPPE Practice Effects:	*0 No Effect*
5 Substantial Improvement	*-1 Slight Worsening*
4 Moderate to Substantial Improvement	*-2 Slight to Moderate Worsening*
3 Moderate Improvement	*-3 Moderate Worsening*
2 Slight to Moderate Improvement	*-4 Moderate to Substantial Worsening*
1 Slight Improvement	*-5 Substantial Worsening*

^ - Conservation Practices Physical Effects

Statement of Work

United States Department of Agriculture Natural Resources Conservation

STATEMENT OF WORK
Lighting System Improvement (670)
National Template

These deliverables apply to this individual practice. For other planned practice deliverable specific Statements of Work.

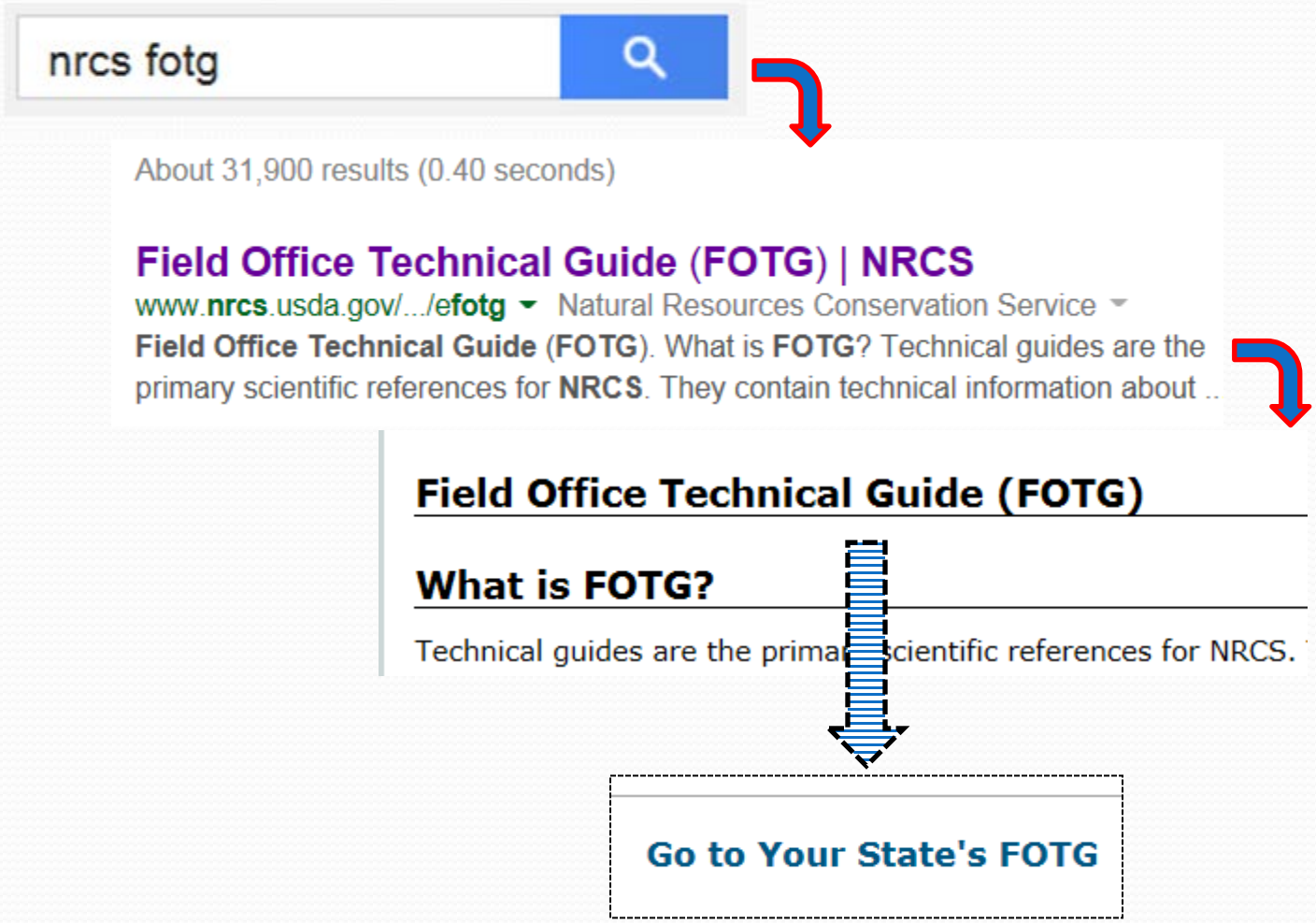
DESIGN

Deliverables:

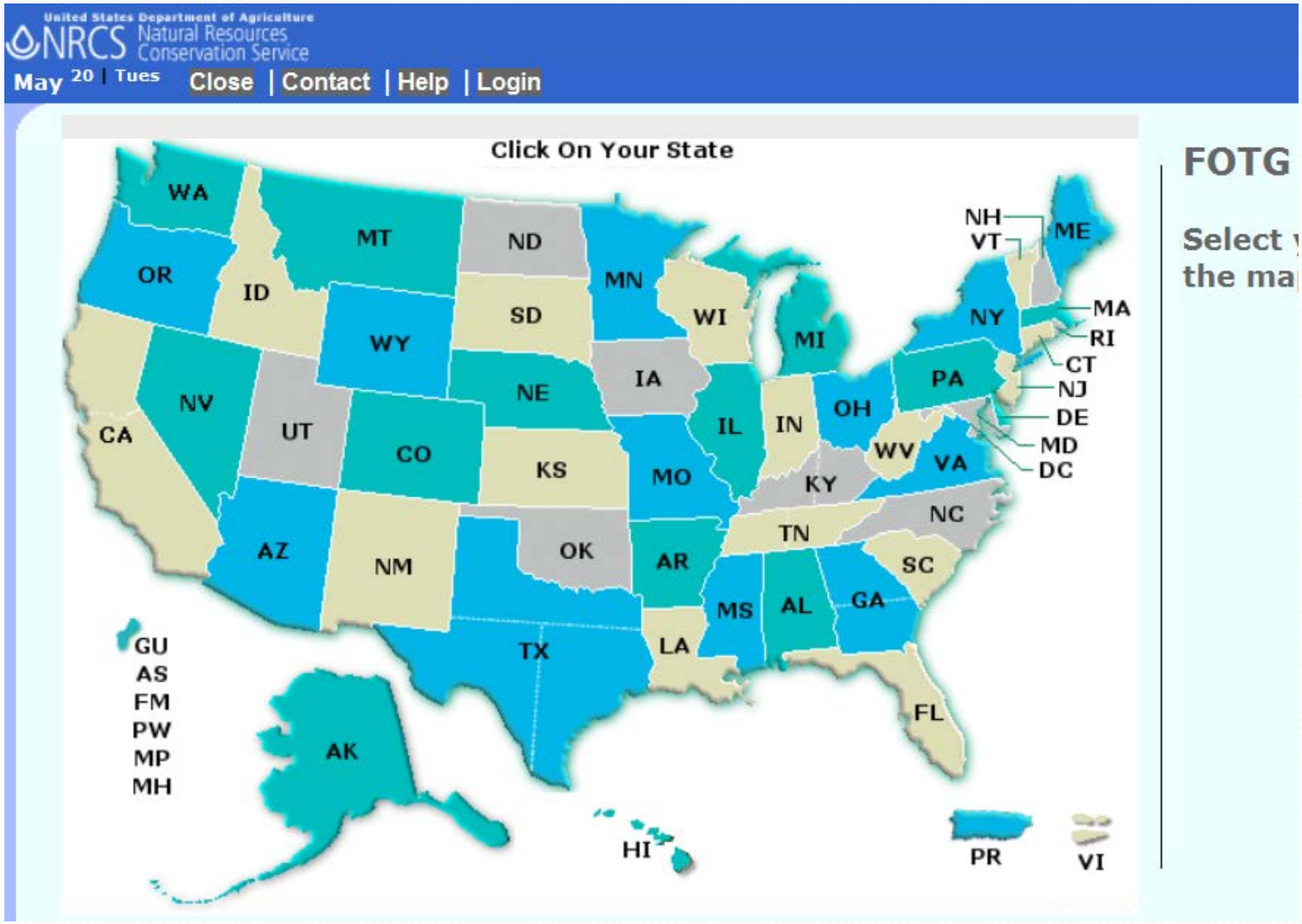
1. Design documents that demonstrate criteria in NRCS practice standard have been met a planned and applied practices
    a. Practice purpose(s) as identified in the conservation plan.
    b. List of required permits to be obtained by the client and regulations to be met
    c. List of facilitating practices
    d. Practice standard criteria-related computations and analyses to develop plans ar including but not limited to:

<?>

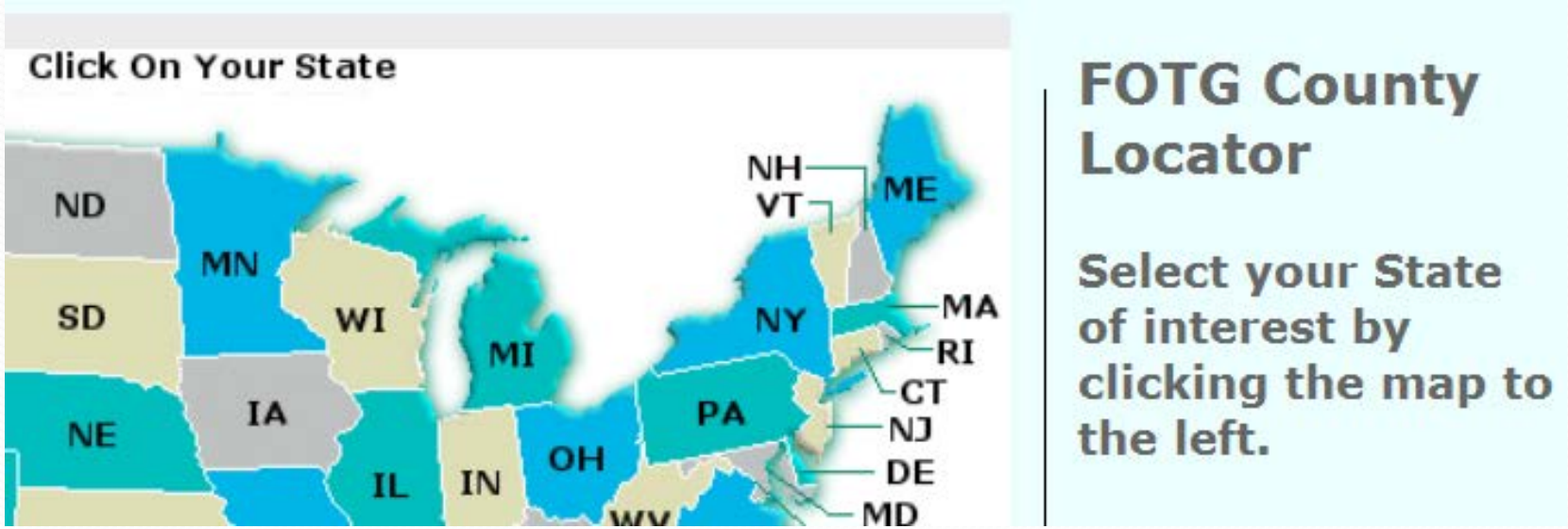
Find a State FOTG



Find a State FOTG (…)



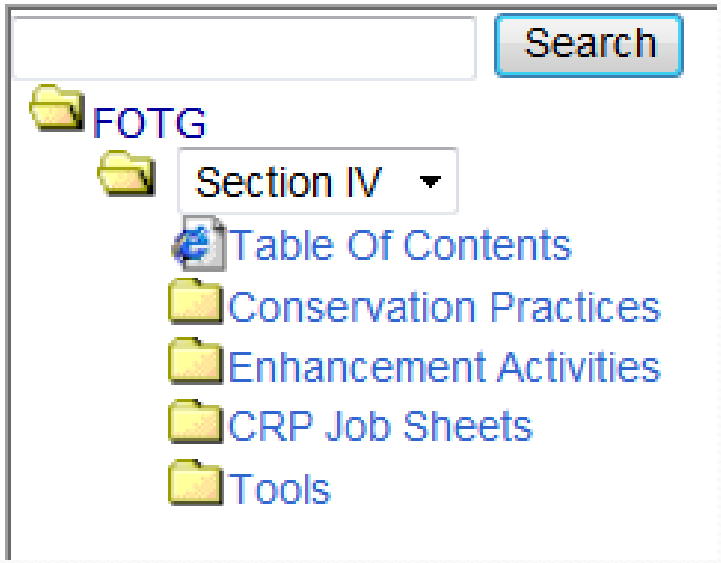
State Lighting (670) CPS



[*http://efotg.sc.egov.usda.gov/*]

Select PA,
Select Applicable County (usu. same result)
Select Section IV …

State Lighting (670) CPS



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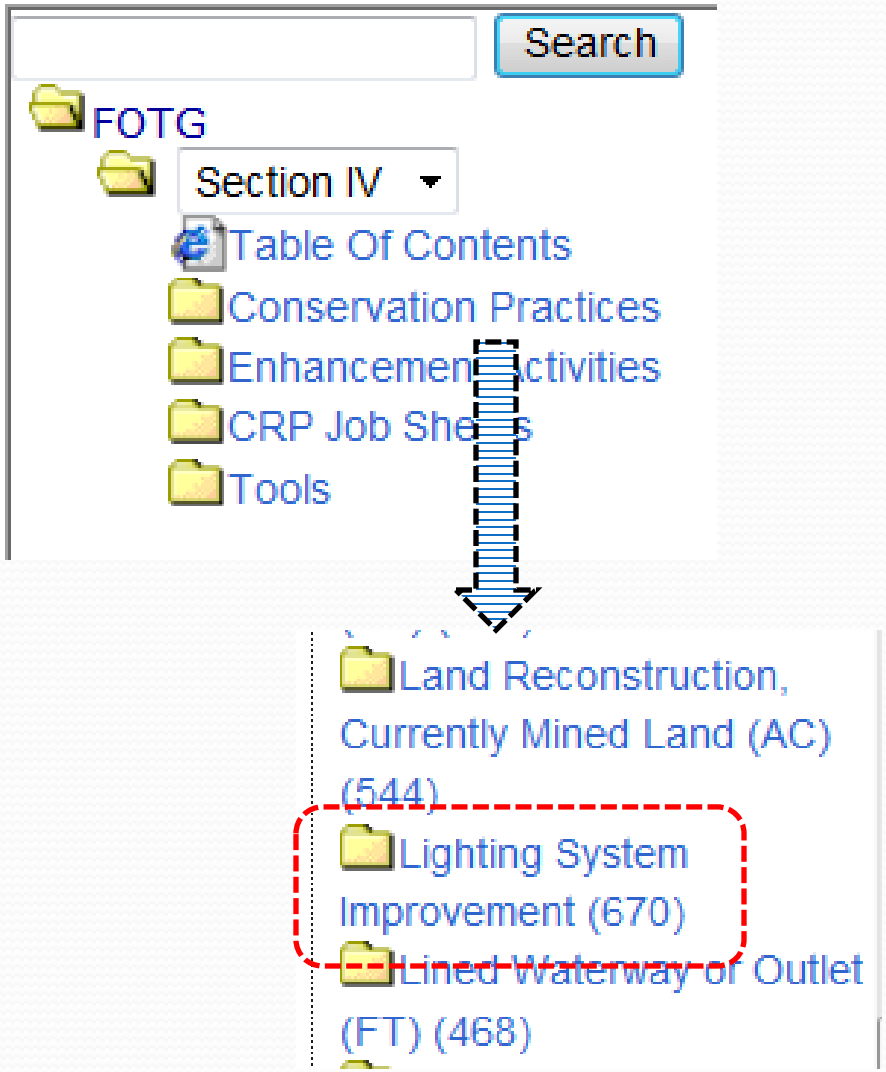

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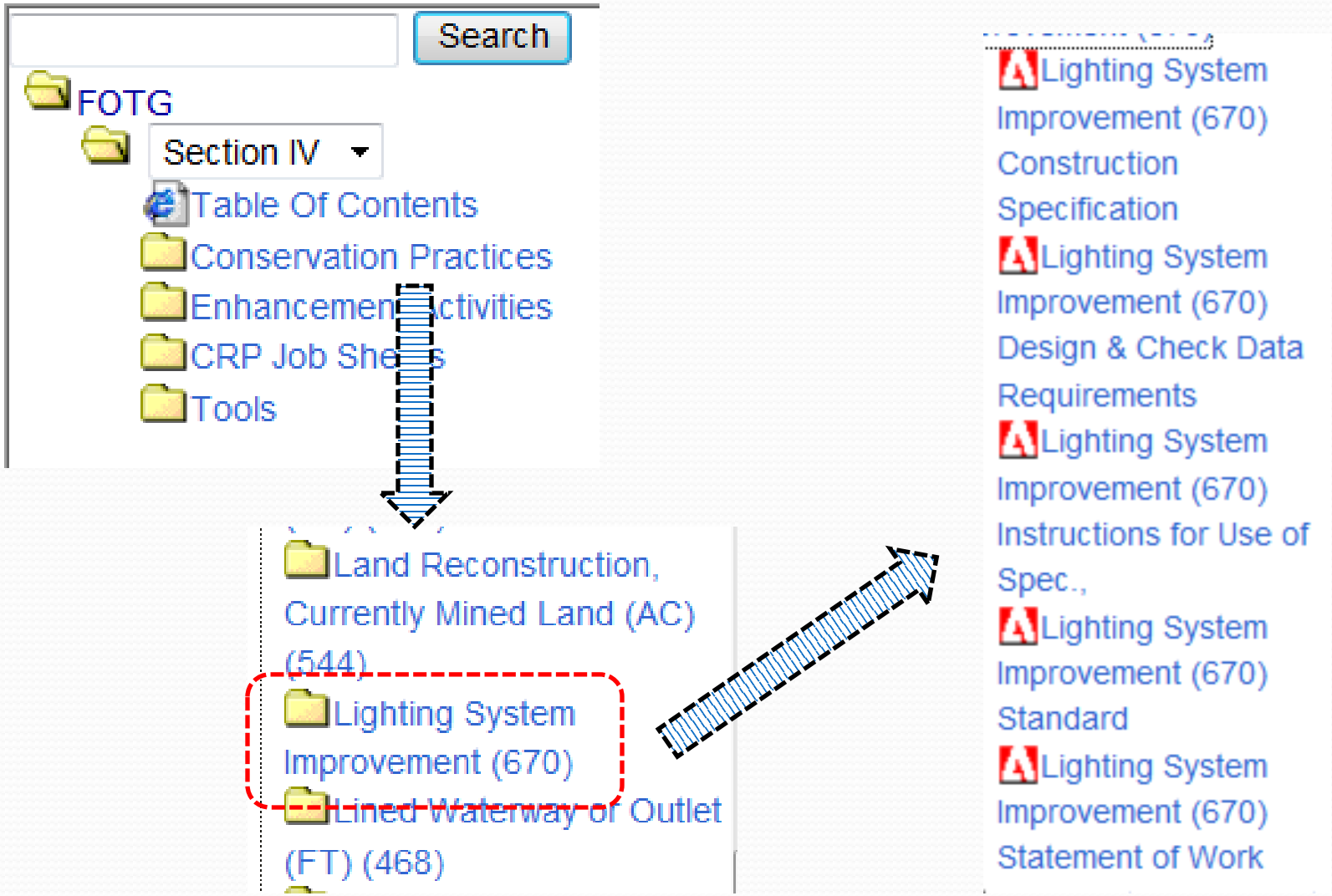
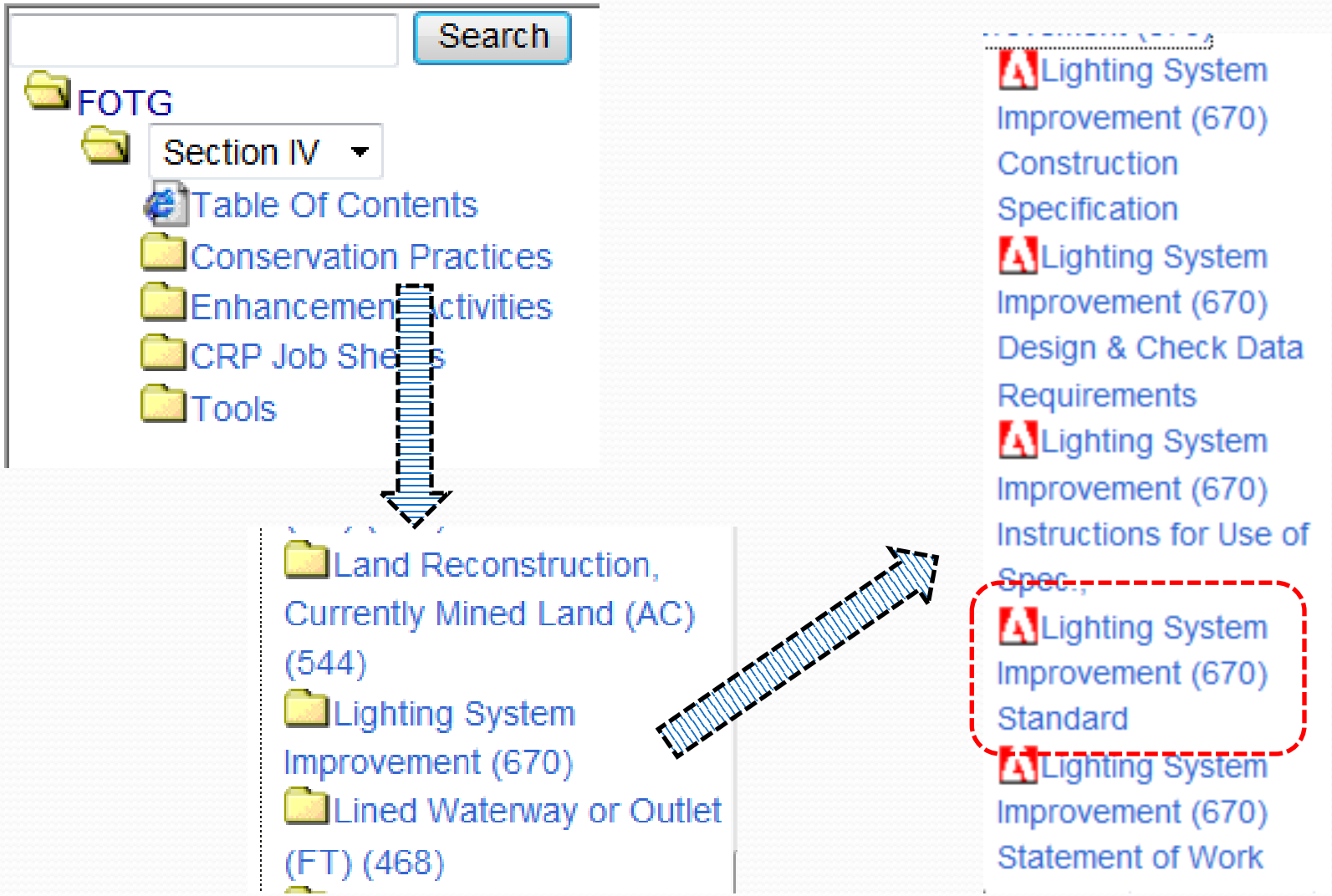


State Lighting (670) CPS



State Standard (.pdf)

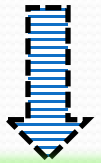
PA670 - 1

CONSERVATION PRACTICE STANDARD

LIGHTING SYSTEM IMPROVEMENT

(No.)

CODE 670



Pennsylvania April 2014

ASABE S612 …

3.9 Type 1 Audit: An evaluation and report of farm enterprise energy use that considers, at a minimum, the major activities highlighted in Table 1, as applicable. A Type 1 Audit is not required to address individual components.

3.10 Type 2 Audit A more detailed evaluation and report of farm enterprise energy use that considers all major activities and components included in Table 1, as applicable.

flashback

NRCS requires Type 2 Audits;

"*… consider all major activities and components in Table 1, as applicable.*"

ASABE S612 …

5 Assessment and Recommendations

5.2 Energy savings at the enterprise level shall be reported in units useable and understandable by the end-user (J, Btu, kWh).

5.3.2 Estimated savings in energy and energy cost, including appropriate assumptions and documentation.

Interpret as:

5.2 – Purchased units (kWh, gallon, therm)

5.3.2 – Show Your Work
(8th grade algebra, science lab, etc.)

The Elizabethan Structure [^]

- Act I – Introduction (Exposition)
- Act II – Rising Action
- Act III - Climax
- Act IV – Falling Action

  may … contain a final moment of suspense,

  … one or more possible outcomes are in doubt

  until the Resolution

- Act V – Dénouement (Resolution)

To Be Determined …

^ - Joshua Patrick: Shakespeare's Five Act Structure