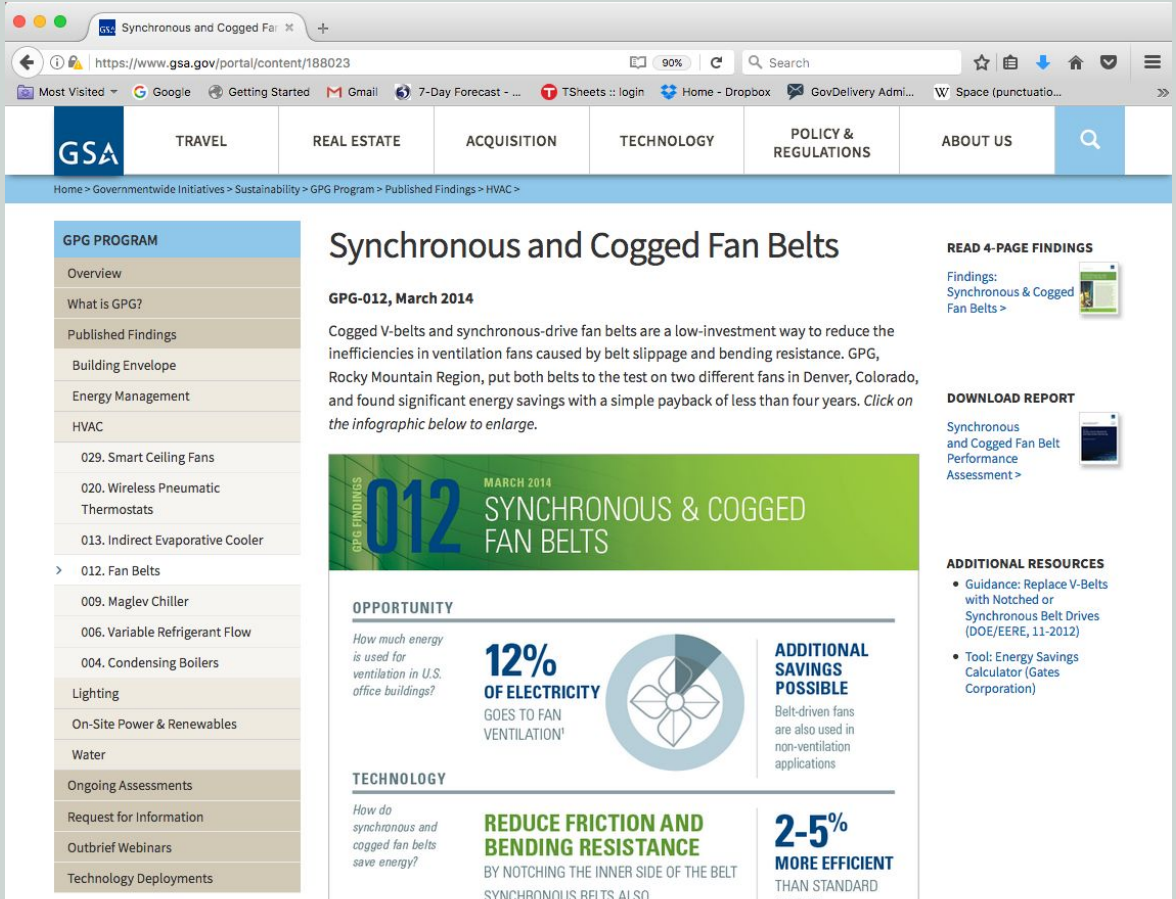
GPG Outbrief 05

Synchronous & Cogged Fan Belts

GPG Program | U.S. General Services Administration | August 10, 2017

GPG-012 Synchronous & Cogged Fan Belts @ gsa.gov/gpg

- Infographic
- 4-page Findings
- Full Report
- Additional Resources



Upcoming GPG Outbriefs—Thursdays, 12 PM ET

September 14	Catalyst-Based Non-Chemical Water Treatment
October 5	Next-Generation Chillers
November 2	Electrochromic Windows

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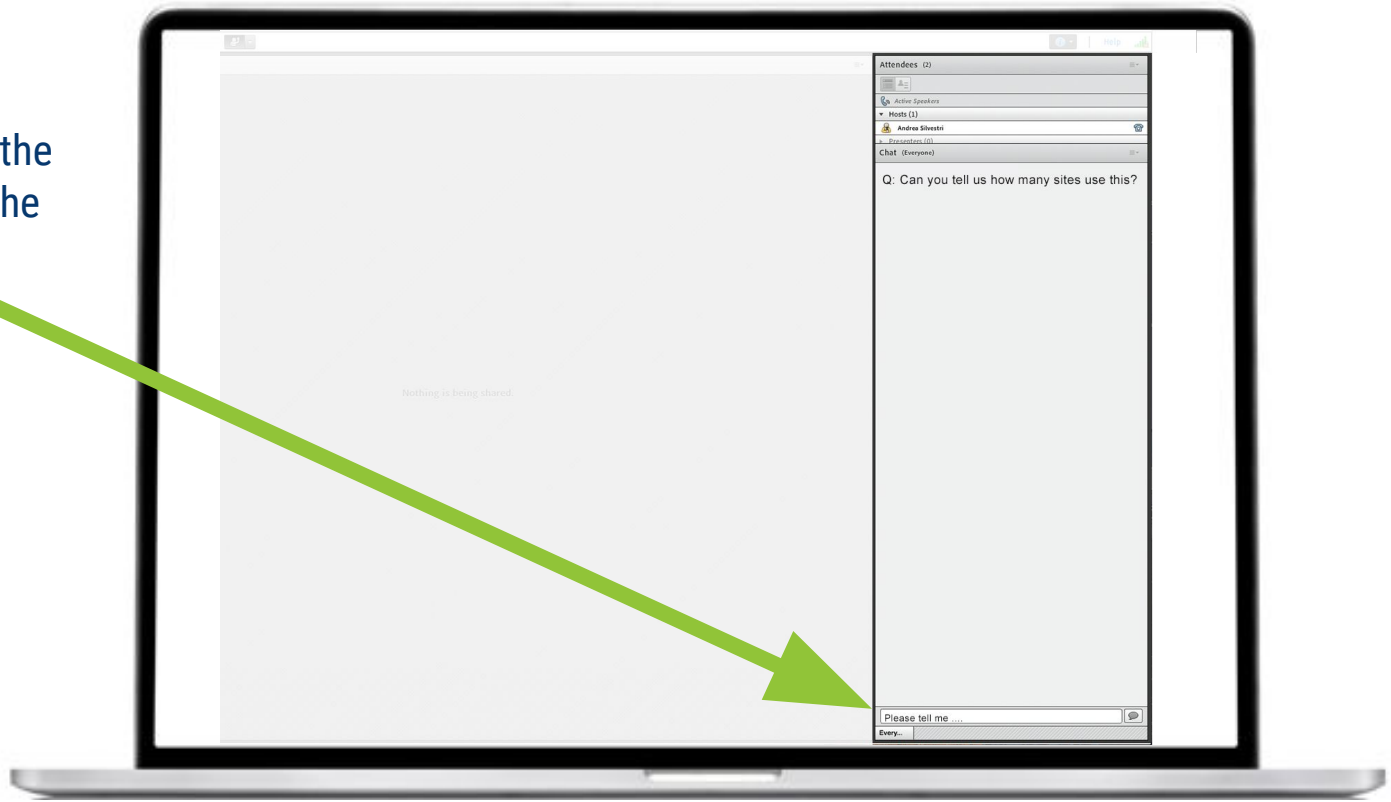

Introduction

Michael Lowell
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Webinar Agenda

- Overview of GPG (5 minutes)
  Kevin Powell, Director, GSA Emerging Technologies
- Synchronous and Cogged Fan Belts (15 minutes)
  Dylan Cutler, National Renewable Energy Laboratory
- On-the-ground Feedback (15 minutes)
  Michael Higdon, Equipment Specialist Region 8
  John Tegan, GSA Region 3
- Q & A (15 minutes)

Introduction

Kevin Powell
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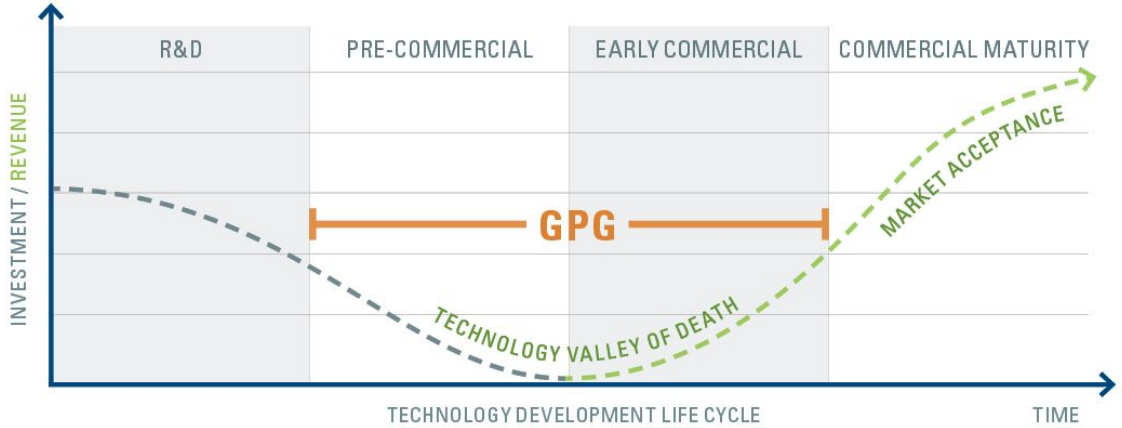
The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

Leading by Example

GSA's Proving Ground accelerates market acceptance by objectively assessing innovative building technologies in real-world environments, and deploying those that deliver. To date, GSA has installed 9 technologies across more than 200 buildings. In aggregate, these technologies are delivering $7.4 Million in annual O&M savings.



GPG Process

Identify promising technologies at the edge of commercialization

Pilot technology installations within GSA's real estate portfolio

Partner with Department of Energy national laboratories to objectively evaluate real-world performance

Recommend technologies with broad deployment potential for GSA

Measurement & Verification

Dylan Cutler
R&D Staff, National Renewable Energy Laboratory

GPG-012

Synchronous and Cogged Fan Belts

General Services Administration
Public Buildings Service

GSA

GPG-012 | MARCH 2014

SYNCHRONOUS AND COGGED FAN BELTS

Synchronous and Cogged Fan Belts Improve Efficiency, Save Energy

Ventilation fans consume a significant portion of the electricity used in U.S. commercial buildings. In fact, ventilation accounts for approximately 12% of total commercial-building electricity use.[1] Total fan energy use is higher still, due to the presence of belt-driven fans in cooling towers and other non-ventilation applications. Inefficiencies account for some of this electricity use, specifically losses that occur during the transfer of energy between motor shafts and fans. Two innovative fan belt technologies that replace the standard V-belt address this issue. Cogged V-belts reduce the amount of material on the inner surface of the belt, and are designed to reduce the bending resistance as the belt travels around the sheave. Synchronous drive belts have teeth that integrate with slots in the sheave (much like a bicycle or motorcycle drive) and are designed to reduce both belt slippage and frictional losses. Belt manufacturers claim energy savings of up to 5% for synchronous drive belts[2] and 2% for cogged V-belts.[3] While this is a small portion of overall building electricity use (between 0.3% and 0.5%), this technology offers a simple and inexpensive way of

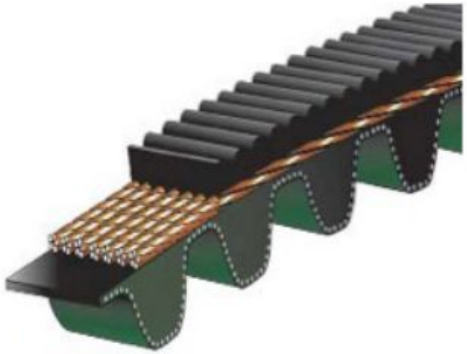
GPG-012. Synchronous and Cogged Fan Belts

Reduced friction and bending resistance for more efficient fan performance

Synchronous belts also reduce slippage by integrating teeth with slots on the motor pulley

Standard V-Belt

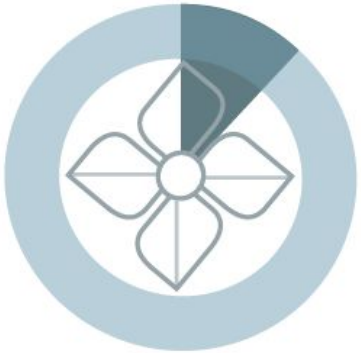
Cogged V-Belt
Reduces bending resistance and friction



Synchronous Drive Belt
Reduces belt slippage and friction

Opportunity

12%
OF ELECTRICITY
GOES TO FAN VENTILATION



2-5%
MORE EFFICIENT
THAN STANDARD V-BELTS

Additional savings possible

Belt-driven fans are also used in non-ventilation applications

Measurement & Verification

NREL assessed belts on CV and VAV fans at the Byron Rogers Federal Courthouse

Byron Rogers Federal Courthouse, Denver

Technology for test-bed measurement and verification, provided by Gates Corporation

Measurement & Verification—Byron G. Rogers Federal Building

Test Plan

- Motor/fan combinations tested with original, standard V-belts to obtain a baseline
- Measured real and apparent electricity consumption, fan speed, motor speed, and sound level with original V-belts, then cogged V-belts and then with synchronous drive belts.
- Motor power consumption normalized for both fan speed and air density changes

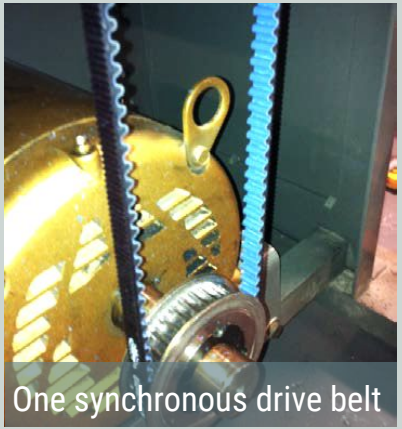
Installation/Operations & Maintenance

75% lower O&M for synchronous

- 1 Synchronous drive belt replaced 2 V-belts on CV fan
- 4 V-belts on VFD fan
- Torque start can damage synchronous drive belts on CV fans

Cogged O&M is equivalent to standard V-belts

Original–2 standard V-belts



One synchronous drive belt

Fan Energy Savings with VFD Drive

Weather-adjusted and fan-speed-normalized savings

Over baseline standard V-belts

VFD Frequency [Hz]	Cogged Savings [W]	Synchronous Savings [W]	Cogged Savings [%]	Synchronous Savings [%]
15	71.9	154.8	9.3%	20.1%
20	56.6	126.0	3.7%	8.1%
25	76.2	123.9	2.8%	4.6%
30	86.6	110.7	1.9%	2.5%
35	327.0	337.1	4.8%	4.9%
40	334.5	345.0	3.4%	3.5%
45	446.6	480.8	3.2%	3.5%
50	601.3	689.6	3.2%	3.7%
55	195.2	378.5	0.8%	1.6%
60	385.2	707.8	1.2%	2.3%

2-20%

ENERGY SAVINGS

FOR SYNCHRONOUS ON VFD
2% AT 60 HZ, 20% AT 15 HZ

Cogged fan belts offered half the savings

VFD Fan Lifecycle Cost Analysis

For fans with VFD drives, synchronous drive belts are the most cost-effective

Cost	V-Belt	Cogged V-Belt	Synchronous Drive Belt
Initial Costs	$379	$419	$1,280
Replacement Costs	$379	$419	$372
O & M Costs	$92	$92	$23
Energy Costs	$4,772	$4,690	$4,608
Lifecycle Costs	**$37,694**	**$37,187**	**$36,809**

Assumes equal lifespans of 3 years. Manufacturer claims a longer lifespan which would enhance economics.

Energy Use for Synchronous Belt on CV Fan

Fan energy consumption with constant volume (CV)

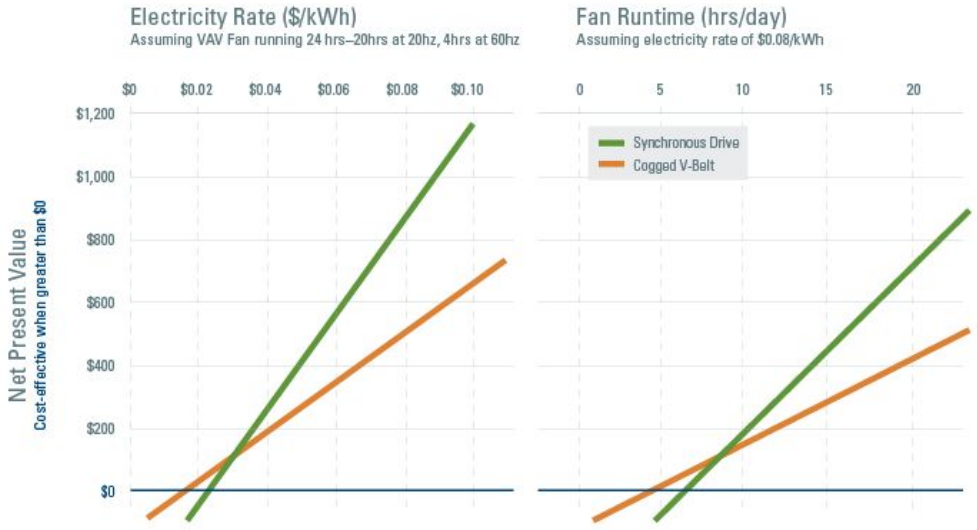
Energy use increases without adjustments to fan control

Belt Type	Compared to Original V-Belt		
	Increase in Fan Speed [RPM]	Increase in Power Consumption [W]	Increase in Efficiency (normalized for fan speed) [%]
Tensioned V-Belt	2.5	45.9	0.001%
Synchronous Drive Belt	21.5	261.5	1.871 %

Fast Payback for Both Belts

Less than 4 year payback for synchronous, repeat installations have immediate payback; cogged payback < 1 year

Synchronous cost-effective at $0.024/kWh or 6.8 hrs/day; cogged cost-effective at $0.015/kWh or 4.3 hrs/day



Installation Lessons Learned – Synchronous Drive Belts

- **Ensure correct size**—Have experienced installer measure pre-existing diameter, belt length, and fan/motor shaft speeds.
- **Consider range of mobility in the motor mount**—the motor may need to move more or less to accommodate synchronous drive belts
- **Use soft start for CV fans**—by reducing initial torque can reduce the chance for tooth jump and wear on the belt

Correct Fan Choice and Expert Installation are Key

- For VFD fans, the synchronous belts showed savings at all ranges of fan operation.
- For CV fans, cogged V-belts are the best solution.
    - Synchronous drive belts pose risks when combined with the CV fan's high-torque starts and increased operational speed. Savings will be greatest on small-diameter motors or fan sheaves and in instances where the installed V-belt was oversized for the sheave diameter.
- No significant change was noted in the sound levels generated by different belt operation.

GSA Deployment Opportunity

Standard v-belts at end-of-life —

- Replace with cogged on all CV fans
- Consider synchronous on VFD fans (best for fans with high operating hours)

New construction and major renovation —

- Install synchronous drive belts with VFD fans

On-The-Ground Feedback

Michael Higdon, R8
Equipment Specialist

Byron Rogers Courthouse

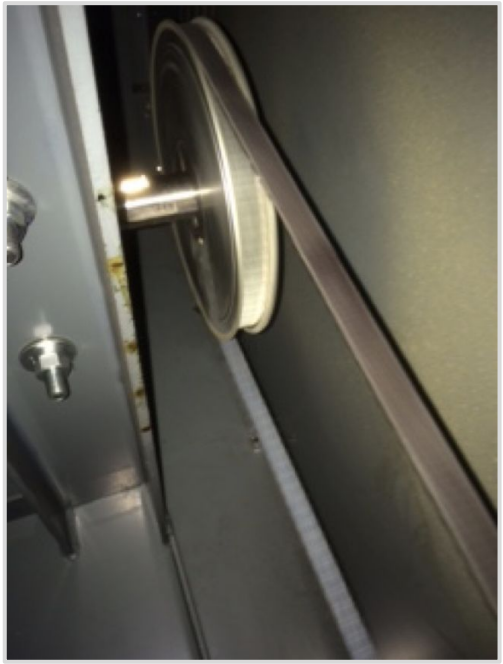
Synchronous Fan Belt on VFD Parking Garage

- 40 hp, 1185 RPM reduced by 67% to 375 RPM in normal operation
- Installed in 2012; 48,000 hours of use
- Shows very little wear

Byron Rogers Courthouse

Synchronous Fan Belt on CV Restroom Ventilation

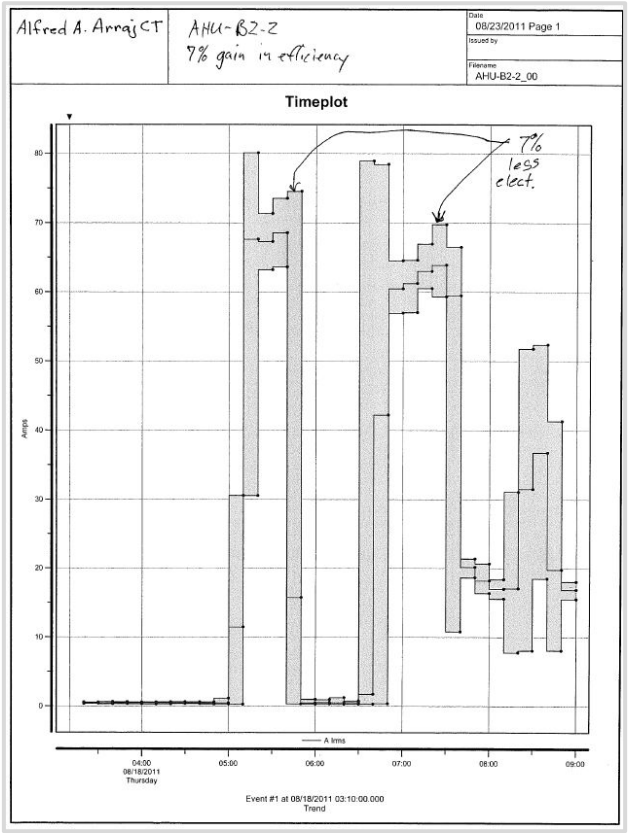
- 10 hp at 1760 RPM, no VFD control, no soft start
- Installed in 2012; 16,000 hours of use
- Nearing end of life, belt is jumping teeth at startup
- Radiates noise throughout the mechanical room
- Originally sized too large and off center and wasn't tight enough, wore away on the side of the belt.



Alfred A. Arraj Courthouse

Synchronous Fan Belts on Air Handlers

- Installed in August 2011
- 17,500 hours of use
- Have not been replaced except for one on July 20th 2017 because sheave and pulley slipped out of alignment
- 7-9% measured electrical savings



On-The-Ground Feedback

John Tegan, C.E.M.
GSA Region 3 Building Operations

R3 Experience

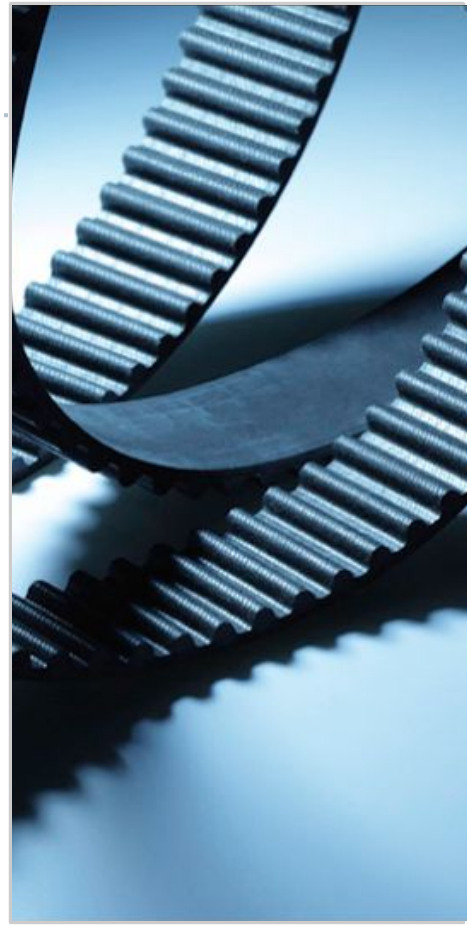
Cogged belts are standard operating procedure

- As EISA Reqs - R3 opted to have NREL Perform initial Building Studies
- All NREL reports recommended replacing standard V-belts with cogged belts
- R3 O&M vendors embraced these findings and switched to cogged belts when performing PM's / at their earliest feasible opportunity
- Cogged are the only belts that are stocked now
- Work was performed as part of O&M contract - no $ outlay or specific project for belts
- Cogged belts are now considered as BEST PRACTICE and operating in the most energy efficient way possible

GSA Deployment

Deployment of Synchronous and Cogged Fan Belts

- Cogged fan belts are standard operating procedure in regions 1, 3, 5



Q & A

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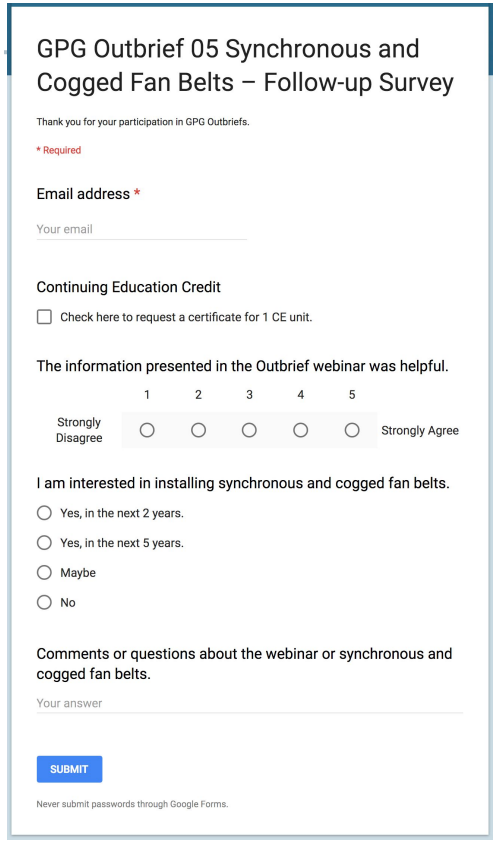

GPG Outbrief 05 Synchronous and Cogged Fan Belts – Follow-up Survey

Thank you for your participation in GPG Outbriefs.

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The information presented in the Outbrief webinar was helpful.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am interested in installing synchronous and cogged fan belts.

- ○ Yes, in the next 2 years.
- ○ Yes, in the next 5 years.
- ○ Maybe
- ○ No

Comments or questions about the webinar or synchronous and cogged fan belts.

Your answer

SUBMIT

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Thank you!

For more information: gsa.gov/GPG

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