

GPG Outbrief 06

# Catalyst-Based Non-Chemical Scale Prevention

GPG Program | U.S. General Services Administration | September 14, 2017

The logo for the U.S. General Services Administration (GSA), consisting of the letters "GSA" in white on a dark blue square background.

GSA

# GPG-019 Catalyst-Based Non-Chemical Scale Prevention @ gsa.gov

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

The screenshot shows a web browser window displaying the GSA website. The URL is <https://www.gsa.gov/portal/content/211883>. The page features a navigation menu with categories: TRAVEL, REAL ESTATE, ACQUISITION, TECHNOLOGY, POLICY & REGULATIONS, and ABOUT US. The main content area is titled "Non-Chemical Water Treatment" and includes a sub-header "GPG-019, February 2015". The text describes standard approaches to calcite mitigation and highlights the benefits of catalyst-based non-chemical water treatment (NCWT) at the Frank E. Moss Federal Courthouse in Salt Lake City, Utah. A sidebar on the left provides a table of contents for the GPG PROGRAM, including sections like Overview, What is GPG?, Published Findings, Building Envelope, Energy Management, HVAC, Lighting, On-Site Power & Renewables, Water, and Technology Deployments. The right sidebar offers links to "READ 4-PAGE FINDINGS", "DOWNLOAD FULL REPORT", and "ADDITIONAL RESOURCES". A large infographic at the bottom of the page features a green background with the text "019 FEBRUARY 2015 CATALYST-BASED NON-CHEMICAL SCALE PREVENTION". Below this, an "OPPORTUNITY" section states that 85% of the United States has hard (>121 mg/L) water. A "TECHNOLOGY" section includes a diagram of a pipe with a helical insert, showing the chemical symbols for Calcium (Ca) and Carbon (C).

Non-Chemical Water Treatment

GPG-019, February 2015

Standard approaches to calcite mitigation rely on chemicals, which must be replenished frequently, or ultra-fine-membrane filtering, which uses large amounts of water and energy. Researchers assessing catalyst-based non-chemical water treatment (NCWT) at the Frank E. Moss Federal Courthouse in Salt Lake City, Utah, found that the technology dramatically reduced calcite buildup and had immediate payback when compared to a chemical (salt-based) system. *Click on the infographic below to enlarge.*

**019** FEBRUARY 2015 CATALYST-BASED NON-CHEMICAL SCALE PREVENTION

**OPPORTUNITY**

*What percentage of the U.S. has hard water?*

**85%** OF THE UNITED STATES HAS HARD (>121 MG/L) WATER

**CALCITE BUILDUP** due to hard water restricts water flow and causes heating systems to overheat and fail

**TECHNOLOGY**

*How does the Catalyst-Based NCWT work?*

PIPE WITH HELICAL INSERT

20 Ca Calcium 6 C Carbon

**READ 4-PAGE FINDINGS**

Findings: Catalyst-Based Non-Chemical Water Treatment >

**DOWNLOAD FULL REPORT**

Catalyst-Based Non-Chemical Water Treatment System Frank E. Moss US Courthouse Salt Lake City, Utah >

**ADDITIONAL RESOURCES**

- Guidance: USGS Water Science School: Hardness (USGS, 05-2016)

# Upcoming GPG Outbriefs—Thursdays, 12 PM ET

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October 12	Biomass Boilers
November 2	Electrochromic Windows
December 7	Next-Generation Chillers
January 18	Socially-Driven HVAC Optimization
February 8	Plug Load Control

## Webinar Recordings

Access all webinars on [GSA.gov](https://www.gsa.gov)

[GSA.gov/GPG](https://www.gsa.gov/GPG)

# Continuing Education Credits

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# How to Chat Your Questions

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Please chat your questions during the presentation for the Q&A segment



# Introduction

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**Michael Lowell**

Project Manager, GPG

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720.641.8891

# Webinar Agenda

- ❑ **Overview of GPG (5 minutes)**  
Kevin Powell, Director, GSA Emerging Technologies
- ❑ **Catalyst-Based Non-Chemical Scale Prevention (15 minutes)**  
Dan Howett, Oak Ridge National Laboratory
- ❑ **On-the-ground Feedback (15 minutes)**  
Daniel Wang, GSA Region 8
- ❑ **Q & A (15 minutes)**

# Introduction

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## **Kevin Powell**

Program Manager, Emerging Technologies

[kevin.powell@gsa.gov](mailto:kevin.powell@gsa.gov)

510.423.3384

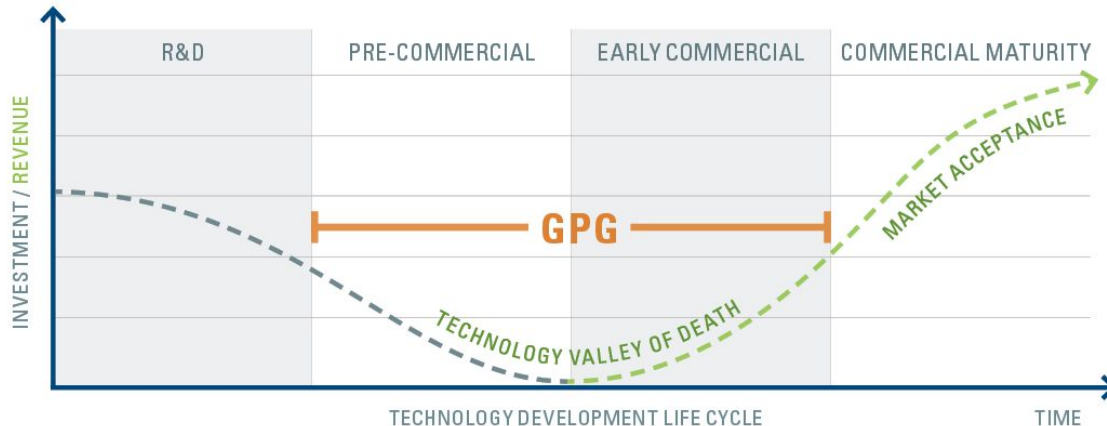




The GPG program enables GSA to make sound investment decisions in next generation building technologies based on their real world performance.

# 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

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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

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**Daniel Howett**

R&D Staff, Oak Ridge National Laboratory

GPG-019

# Catalyst-Based Non-Chemical Scale Prevention

General Services Administration  
Public Buildings Service



GPG-019 | FEBRUARY 2015

## CATALYST-BASED NON-CHEMICAL SCALE PREVENTION

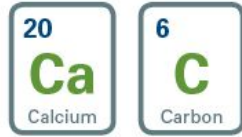


### Catalyst-Based Device Reduces Calcite Buildup, Requires Minimal Maintenance

According to the US Geological Survey, more than 85 percent of the United States has hard water.<sup>1</sup> In plumbing, hard water leaves calcite deposits that restrict water flow by occluding pipes. In water heaters, calcite coats heating elements, causing them to overheat and eventually fail. Standard approaches to calcite mitigation rely on chemicals, which must be replenished frequently, or ultra-fine-membrane filtering, which uses large amounts of water and energy. GSA's GPG program commissioned Oak Ridge National Laboratory (ORNL) to assess the effectiveness of a catalytic insert that alters the chemistry of hard water to prevent calcite buildup. Researchers assessing the technology at the Frank E. Moss Federal Courthouse in Salt Lake City, Utah, found that catalyst-based non-chemical water treatment (NCWT) dramatically reduced calcite buildup and had immediate payback when compared to a chemical (salt-based) system. Payback at other locations will depend on the ongoing remediation costs of calcite buildup. Catalyst-based NCWT should be considered for deployment in any heating system that

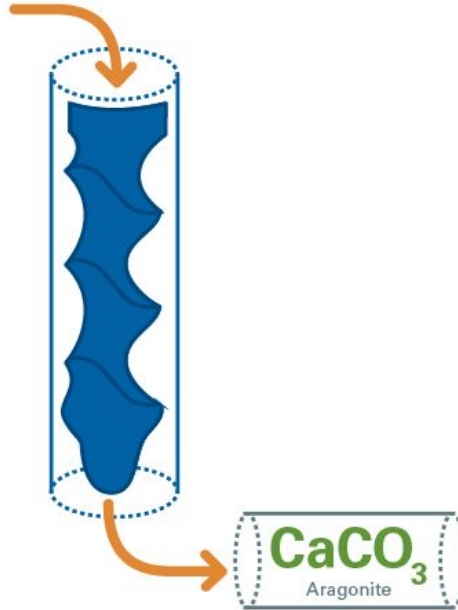
# GPG-019. Catalyst-Based Non-Chemical Scale Prevention

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**PIPE WITH  
HELICAL INSERT  
PREVENTS  
CALCITE BUILDUP**

BY TRANSFORMING CALCIUM  
AND CARBON TO FLUSHABLE  
ARAGONITE CRYSTALS

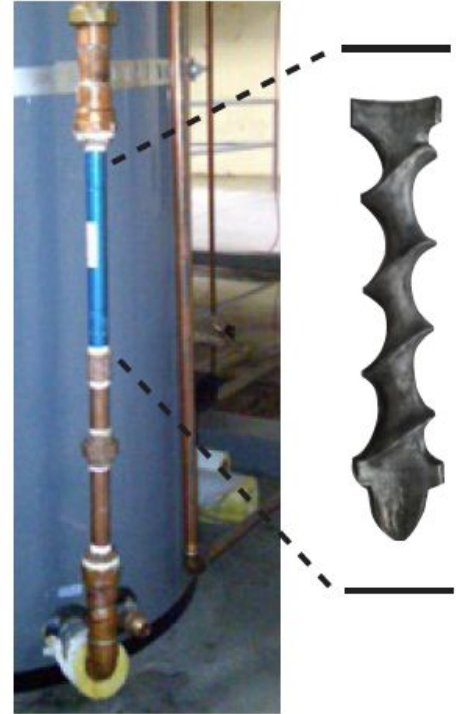


# GPG-019. Catalyst-Based Non-Chemical Scale Prevention

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## Pipe with installed in cold-water and recirculating line

- Unit size varies based on flow rate.
- Smallest  $\frac{3}{8}$ " diameter, treats 0.4 to 1.9 gpm, targeted for ice maker or small appliance.
- Available in larger sizes up to 12", treats 2,200–3,800 gpm. Custom units up to 72" in diameter are available.
- Proprietary technology with one manufacturer. Commercially available in Europe and Asia since 1973, brought to the US in 2010.



## Opportunity

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**85%**

**OF THE UNITED STATES HAS  
HARD (>121 MG/L) WATER**

### **CALCITE BUILDUP (due to hard water)**

- Restricts water flow
- Reduces performance
- Can cause heating systems to overheat and fail



# Measurement & Verification

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Oak Ridge National Laboratory assessed a catalytic insert at Moss Federal Courthouse



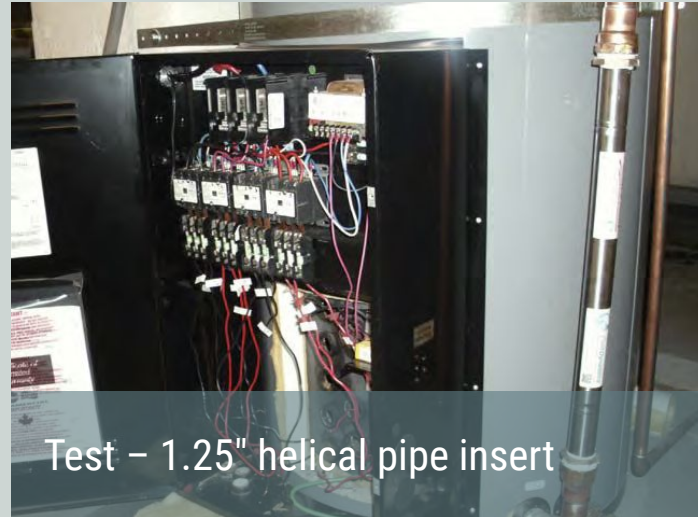
Frank E. Moss Federal Courthouse, Salt Lake City

# Measurement & Verification—Moss Federal Courthouse

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**Baseline** with new heating elements (3 months).

**Test** with new heating elements and non-chemical scale prevention (3 month plan).



# Measurement & Verification—Moss Federal Courthouse

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## Heating elements failed after 7 weeks

20 gpg flow rate not correct in design documents, measured at 6–11 gpg.

Heating elements not designed for commercial service.



# Measurement & Verification—Moss Federal Courthouse

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Second round of testing—tracked before and after for 3 months



Baseline – w/commercial inserts



Test (6/2013) – .75" helical pipe insert

## Before & After—Commercial Elements & Correctly Sized Insert

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Before Non-Chemical Scale Prevention

Calcite buildup after 6 weeks of untreated operation caused heating elements to overheat and fail.



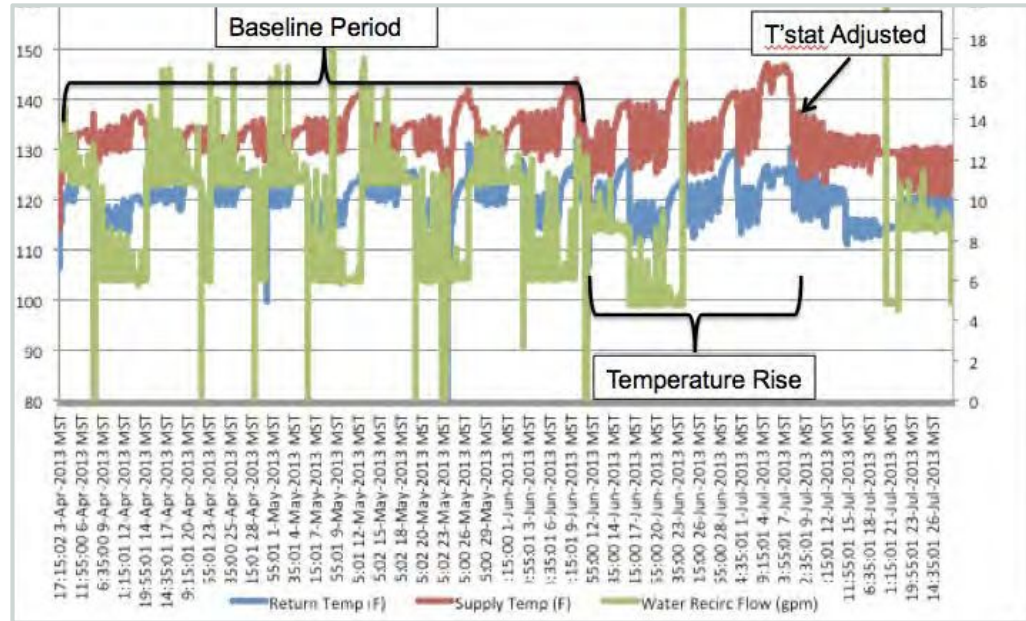
After Non-Chemical Scale Prevention

New heating elements show no significant signs of calcite buildup or overheating 18 months after installation of non-chemical scale prevention technology.

# Temperature Rise after Helical Insert

## Better heat transfer

Due to reduced buildup of calcium on heating elements.



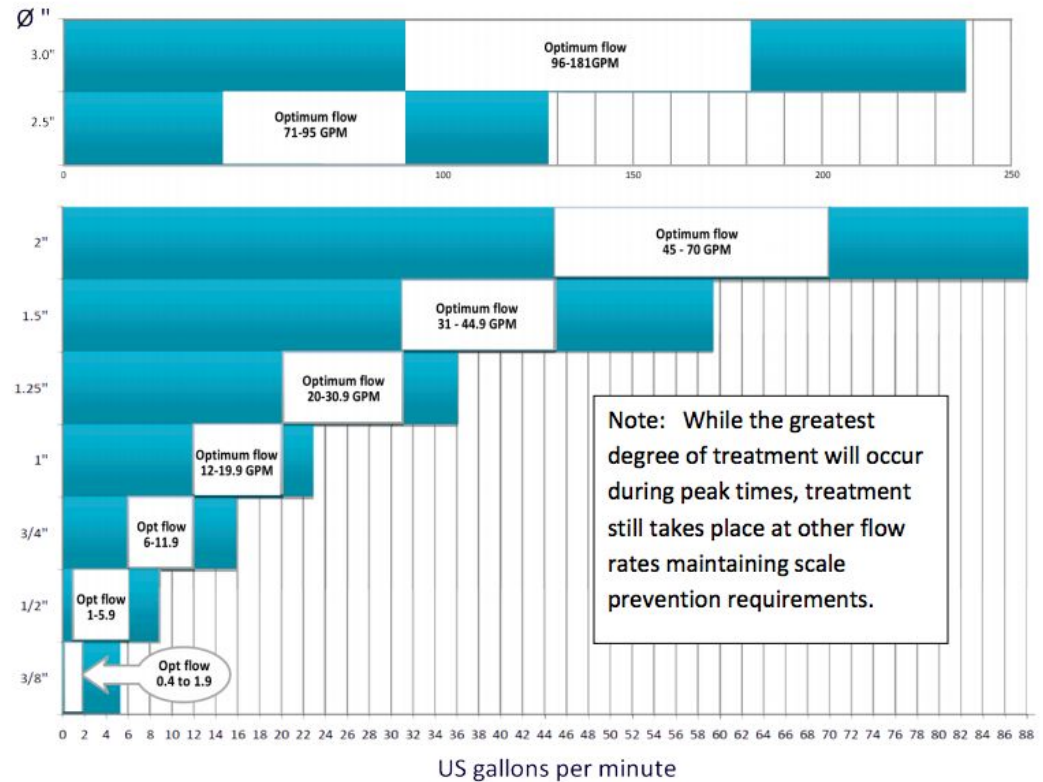
# Minimal Operations & Maintenance

## No moving parts or chemicals

Systems with high iron content may require periodic cleaning.

In systems without a drain, calcite can form in the bottom of the tank and should be removed every 18 to 24 months.

Diameter • Actual maximum throughput (GPM) will vary according to system pressure



## <2 Year Payback; Immediate When Compared to Chemical

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### Non-chemical scale prevention vs. salt-based system in Salt Lake City

	Salt-Based System	Catalyst-Based Non-Chemical Scale Prevention
Equipment Cost	\$2,600	<b>\$1,192—<math>\frac{3}{4}</math>" diameter unit</b> Unit pricing ranges between \$798 for a $\frac{3}{8}$ " pipe and \$96,360 for a 16" pipe.
Installation Cost	\$600	<b>\$500 —10 hours @ \$50/hr</b> Installation for new construction is \$0, as it incurs no additional costs over baseline.
Maintenance Costs/year	<b>\$1,850—\$350 chemicals, \$1,500 labor</b>	<b>\$100—biannual tank cleaning</b> Required in systems without a drain.
Simple Payback		<b>Immediate</b>



## Lessons Learned

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- ❑ **Device sizing is key to performance** – A flow test using ultrasonic meters should be used to determine appropriate device sizing.
- ❑ **Appropriate element selection yields maximum effectiveness** – Electric heating elements should match appliance specifications.

# GSA Deployment Opportunity

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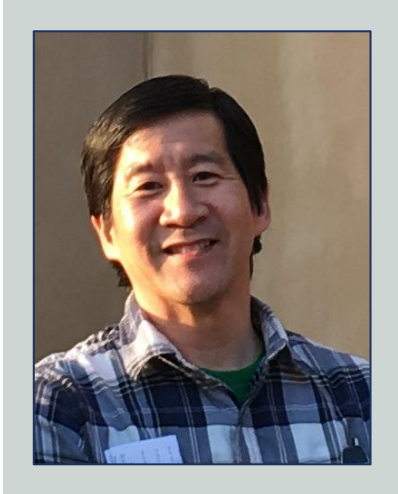
## Best suited to facilities with hard water

- Any heating system with calcification issues including hydronic heating systems and boilers, condensing boilers, and gas and electric water heaters.
- Has also worked for commercial ice machines to eliminate scale accumulation (*vendor claim, not tested by GPG*).
- The harder the water, the more likely NCWT will be cost-effective. Likely to be cost-effective for any facility with water hardness greater than 300 mg/litre.



# On-The-Ground Feedback

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**Daniel Wang, R8**  
Facility Manager

# Frank E. Moss Courthouse, Salt Lake City

In place for 4 years, has saved us ~\$57K.

- Insert has now been in place since June 2013.
- Initially replacing heating elements every 6 weeks at a cost of \$1,200.
- The incoming water hardness at the Moss CH is 19 to 25 gpg.
- The heating elements are replaced when one fails; approximately every 12 months.
- While the tank is drained, it is cleaned and sediment is vacuumed out.

Water Hardness Scale		
Grains/Gal	mg/L or PPM	Classification
Less than 1	Less than 17.1	Soft
1-3.5	17.1-60	Slightly Hard
3.5-7	60-120	Moderately Hard
7-10	120-180	Hard
Over 10	Over 180	Very Hard
19-25	324.9-427.5	Moss CH Hard
1 gpg = 17.1 mg/L = 17.1 ppm		

The degree of hardness standard as established by the American Society of Agricultural Engineers (S-339) and the Water Quality Association (WQA)  
<https://www.wqa.org/learn-about-water/perceptible-issues/scale-deposits>

# Frank E. Moss Courthouse, Salt Lake City

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## Installation

- Plug and play technology.

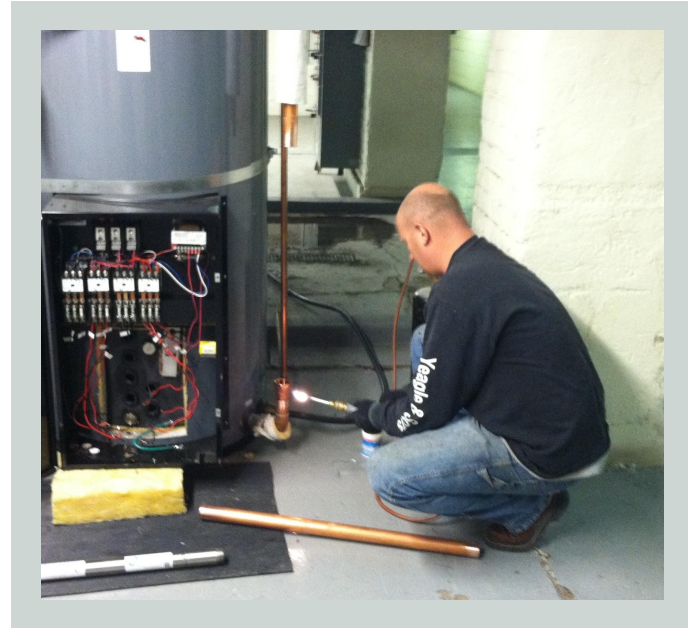


# Frank E. Moss Courthouse, Salt Lake City

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## Installation

- Plug and play technology.
- Straight-forward installation similar to standard pipe plumbing.



# Frank E. Moss Courthouse, Salt Lake City

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## Installation

- Plug and play technology.
- Straight-forward installation similar to standard pipe plumbing.
- Measuring flow could be a barrier if you don't already have a flow meter; ~\$200 to monitor flow.



# Frank E. Moss Courthouse, Salt Lake City

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## Installation





Q & A

# Survey and Continuing Education Credit

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Thank you for your participation in GPG Outbriefs.

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Check here to request a certificate for 1 CE unit.

AIA Number

Your answer

First Name and Last Name

Your answer

The information presented in the Outbrief webinar was helpful.

1 2 3 4 5  
Strongly Disagree      Strongly Agree

I am interested in installing catalyst-based non-chemical scale prevention.

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

Comments or questions about the webinar or catalyst-based non-chemical scale prevention.

Your answer

Thank you!



For more information: [gsa.gov/GPG](https://gsa.gov/GPG)

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