



**Memorandum from the Office of the Inspector General**

April 14, 2016

James R. Dalrymple, LP 3K-C  
Laura A. Green, BR 4A-C

**REQUEST FOR FINAL ACTION – AUDIT 2014-15081 – TVA'S MITIGATION OF RISKS  
FROM BULK INDUSTRIAL GASES**

Attached is the subject final report for your review and final action. Your written comments, which addressed your management decision and actions planned or taken, have been included in the report. Please notify us when final action is complete. In accordance with the Inspector General Act of 1978, as amended, the Office of the Inspector General is required to report to Congress semiannually regarding audits that remain unresolved after 6 months from the date of report issuance.

Information contained in this report may be subject to public disclosure. Please advise us of any sensitive information in this report that you recommend be withheld.

If you have any questions or wish to discuss our findings, please contact Jamie M. Wykle, Senior Auditor, at (865) 633-7382 or Lisa H. Hammer, Director, Evaluations – Organizational Effectiveness, at (865) 633-7342. We appreciate the courtesy and cooperation received from your staff during the audit.

David P. Wheeler  
Assistant Inspector General  
(Audits and Evaluations)  
ET 3C-K

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Attachment  
cc (Attachment):

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OIG File No. 2014-15081



Office of the Inspector General

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## *Audit Report*

To the Senior Vice President,  
Power Operations, and to the  
Vice President, Supply Chain

# **TVA'S MITIGATION OF RISKS FROM BULK INDUSTRIAL GASES**

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Auditor  
Jamie M. Wykle

Audit 2014-15081  
April 14, 2016

## **ABBREVIATIONS**

FY	Fiscal Year
GAF	Gallatin Fossil Plant
NFPA	National Fire Protection Association
OSHA	Occupational Safety and Health Administration
TVA	Tennessee Valley Authority
WCF	Widows Creek Fossil Plant

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- A. MITIGATIONS DESIGNED TO ADDRESS RISKS RELATED TO BULK INDUSTRIAL GASES
  
- B. MEMORANDUM DATED APRIL 6, 2016, FROM JAMES R. DALRYMPLE AND LAURA A. GREEN TO DAVID P. WHEELER



# Audit 2014-15081 – TVA's Mitigation of Risks From Bulk Industrial Gases

## EXECUTIVE SUMMARY

### Why the OIG Did This Audit

The Tennessee Valley Authority (TVA) uses bulk industrial gases including oxygen, hydrogen, nitrogen, and carbon dioxide as part of its normal operations. Due to hazards associated with handling bulk industrial gases and the importance of worker and public safety at TVA, we initiated an audit of TVA's mitigation of risks from bulk industrial gases. We limited our scope to the explosive and flammable risks of hydrogen and oxygen and the asphyxiation risks of nitrogen and carbon dioxide. Our audit objective was to determine whether TVA designed mitigating actions for fire, explosion, and asphyxiation risks related to hydrogen, oxygen, nitrogen, and carbon dioxide bulk industrial gases.

### What the OIG Found

We determined TVA designed mitigating actions for fire, explosion, and asphyxiation risks related to hydrogen, oxygen, nitrogen, and carbon dioxide bulk industrial gases. However, we identified several areas for improvement to further mitigate the risks from bulk industrial gases. Specifically, we found (1) contract terms did not require a supplier to provide TVA with inspection and maintenance reports for bulk gas tanks, (2) emergency plans do not list types and quantities of on-site gases, and (3) unsecured portable compressed gas cylinders at Gallatin Fossil Plant and Widows Creek Fossil Plant.

### What the OIG Recommends

We recommend the Senior Vice President, Power Operations:

1. Update site emergency plans to identify types and quantities of compressed gases and cryogenic fluids stored at generating plants.
2. Assess the root cause of unsecured compressed gas cylinders at Gallatin Fossil Plant and Widows Creek Fossil Plant and address as appropriate.

In addition, we recommend the Vice President, Supply Chain, amend gas supplier contracts to require suppliers to provide TVA with inspection and maintenance reports that (1) show contractor compliance with appropriate inspection/maintenance-related codes and regulations and (2) enable TVA to confirm the supplier is meeting its obligations for tank safety.



## Audit 2014-15081 – TVA’s Mitigation of Risks From Bulk Industrial Gases

### EXECUTIVE SUMMARY

#### TVA Management’s Comments

In response to our draft audit report, TVA management agreed with our findings and provided the actions they have taken or plan to take to address each of our recommendations. See Appendix B for TVA management’s complete response.

## **BACKGROUND**

Bulk industrial gases, such as hydrogen, oxygen, nitrogen, and carbon dioxide, are used within the power industry, including the Tennessee Valley Authority (TVA), at generating facilities for a variety of reasons. Hydrogen is used at TVA fossil, nuclear, and some of its gas plants to cool generators. Bulk oxygen is used in hydroelectric generation aeration facilities to improve water quality within the reservoir. Nitrogen is used to keep core temperatures low in nuclear plants as well as to prevent corrosion in boiler layups<sup>1</sup> at fossil plants. Carbon dioxide is used by TVA for purging generators for maintenance. In addition, a majority of TVA's generating plants use high- and low-pressure carbon dioxide in fire protection systems, but nitrogen is also used in some TVA fire protection systems. According to TVA's Supply Chain personnel, five vendors supply bulk industrial gases to TVA: Airgas USA LLC, Air Liquide America LP, Air Products and Chemicals, Linde LLC, and Praxair Inc.

Each type of gas has its own unique chemical and physical properties that present hazards and potential risks:

- **Hydrogen** – TVA uses hydrogen in both gas and cryogenic liquid<sup>2</sup> form. Hydrogen is odorless, colorless, tasteless, and nontoxic. Due to its flammable properties, hydrogen poses violent combustion or explosion risks. Hydrogen is lighter than air and rises quickly. To become an explosion or fire hazard, hydrogen must be confined, such as in a roofed structure or poorly ventilated room, collect in adequate concentration, and be near an ignition source and oxidizer, such as oxygen. While hydrogen is nontoxic, it can also be an asphyxiate if it displaces oxygen, but the amount of gas needed to produce an oxygen-deficient atmosphere is within the flammable range, making fire and explosion the primary hazards. All cryogenic liquids, including hydrogen, cause a severe frostbite, burn-like injury, if skin contacts the liquid or gas and brief exposures that would not affect skin on the face or hands can damage delicate tissues such as the eyes. Personal protective equipment must be used when handling cryogenic liquids.
- **Nitrogen and Carbon Dioxide** – TVA uses nitrogen and carbon dioxide in both gas and liquid form. Nitrogen and carbon dioxide are colorless and odorless. Although nitrogen and carbon dioxide do not burn or support combustion, both gases can cause asphyxiation if a leak is not detected or the gases are used in a confined space.<sup>3</sup> Therefore, when using carbon dioxide or nitrogen indoors or in confined spaces, the areas must be well ventilated. According to the Occupational Safety and Health Administration (OSHA), carbon dioxide concentrations of 10 percent (100,000 parts per

<sup>1</sup> A "layup" refers to blanketing nitrogen around a generator or boiler to purge oxygen out and create a noncorrosive atmosphere.

<sup>2</sup> A cryogenic liquid is defined as a liquid with a normal boiling point below -130°F (-90°C).

<sup>3</sup> OSHA defines a confined space as an area large enough for a worker to enter and perform certain jobs. A confined space has limited or restricted means for entry and exit and is not designed for continuous occupancy.

million) or more can be fatal. Liquid nitrogen and carbon dioxide are also cryogenic liquids and carry the same frostbite risks as liquid hydrogen. In addition, small amounts of a cryogenic liquid can evaporate into very large volumes of gas. For example, a small liquid nitrogen leak can displace oxygen in the air, reducing the percentage of oxygen to below safe levels. OSHA considers any atmosphere with an oxygen level below 19.5 percent to be oxygen deficient and immediately dangerous to life or health.

- **Oxygen** – TVA uses oxygen in cryogenic liquid form. Liquid oxygen is colorless, odorless, and tasteless. Due to its highly reactive properties, oxygen poses explosion and fire risks. As an oxidizer, oxygen can vigorously accelerate combustion of flammable gases and combustible materials including oil or grease. Liquid oxygen is also a cryogenic fluid and carries the same frostbite risks described above.

According to news articles, incidents involving hydrogen in the utility industry over the past several years have demonstrated the danger of explosion if safety measures are not in place or not followed. For example, an explosion occurred in 2007 during a routine hydrogen delivery at an Ohio coal plant when a relief device failed. The explosion killed the truck driver, injured ten people, and damaged several buildings. Another explosion occurred during 2011 at a coal-fired plant in North Carolina when hydrogen was not fully purged from the generator and was ignited by a fan or work light killing one worker. The identified causes and contributing conditions of these and other industry incidents included improper delivery or unloading practices, unsafe maintenance practices, and control room errors.

Examples of incidents at TVA include the following:

- A hydrogen explosion in December 2011 occurred at Widows Creek Fossil Plant (WCF) as a full hydrogen tube trailer was being placed in the port, but no injuries occurred. According to a TVA Operating Experience Communication, the explosion was caused by a misalignment of valves that occurred during the hydrogen transfer operations. This resulted in the inadvertent release of hydrogen, combined with a static discharge that was believed to be caused by inadequate grounding which acted as an ignition source for the resulting explosion.
- In August 2014, lightning struck TVA's Douglas Hydroelectric facility's oxygen tank resulting in a fire, but again, no injuries occurred. According to a TVA River Operations employee, because of remote control capabilities in place, the River Forecast Center, where oxygen systems are monitored, reacted quickly when the lightning strike was reported and vented off the oxygen to prevent the spread of fire and protect equipment at the facility.



## **OBJECTIVE, SCOPE, AND METHODOLOGY**

Due to the importance of worker and public safety at TVA and the hazards associated with handling bulk industrial gases, we initiated an audit of TVA's mitigation of risks from bulk<sup>4</sup> industrial gases. We limited our scope to the explosive and flammable risks of hydrogen and oxygen and the asphyxiation risks of nitrogen and carbon dioxide. After visiting two nuclear plants, Browns Ferry and Sequoyah, we decided to remove nuclear from our scope because nuclear plants fall under strict regulation from the Nuclear Regulatory Commission and due to no negative observations during our visits. Our audit objective was to determine whether TVA designed mitigating actions for fire, explosion, and asphyxiation risks related to hydrogen, oxygen, nitrogen, and carbon dioxide bulk industrial gases.

To achieve our objective, we:

- Identified uses, properties, risks, and safe handling guidance associated with hydrogen, oxygen, nitrogen, and carbon dioxide through review of Material Safety Data Sheets and relevant standards and codes.
- Reviewed hydrogen, oxygen, nitrogen, and carbon dioxide incidents in the news to understand types, causes, effects, and corrective actions.
- Reviewed enterprise risk management best practices to determine what is considered a risk mitigation in the design of control activities, such as policies and procedures.
- Interviewed personnel in TVA's Safety, Supply Chain, and Power Operations business units to identify (1) uses of bulk industrial gases, (2) safety concerns, (3) bulk gas purchases and vendors, and (4) potential mitigations, including fire protection and engineering initiatives, as well as corrective actions related to fire protection and hydrogen port modifications following hydrogen incidents at fossil plants. In addition, we surveyed five TVA Safety Consultants assigned to fossil and gas plants and three Gas Operations regional Senior Managers to obtain additional information on the four areas listed above.
- Reviewed the following to determine risk and mitigating actions:
  - TVA programs, such as safety, fire protection, emergency, and operations initiatives, related to bulk industrial gases including handling, use, and storage.
  - A nonstatistical sample of three fossil plants and three gas sites to determine if gases stored on-site were identified in emergency plans. Sample selection was based upon 2014 site emergency response plans that were readily available in TVA's Procedure Center for the fossil plants we selected to visit (Colbert, WCF, and Bull Run) and all three 2014 gas site plans available in TVA's Procedure Center (Gleason Combustion

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<sup>4</sup> We defined bulk industrial gases to include the storage of gases in bulk and microbulk tanks and tube trailers and excluded the storage of smaller quantities in portable cylinders.

Turbine Plant, Southaven Combined Cycle Plant, and Lagoon Creek Combustion Turbine Plant).

- A nonstatistical sample of 35 TVA fire incidents randomly selected from a population of 877 incidents (620 Problem Evaluation Reports and 257 Operations Information Center Fire Log events) to identify conditions and actions related to bulk industrial gases logged in the Operations Information Center and Problem Evaluation Reports for fiscal year (FY) 2008 through FY2014 in Maximo.
- Nonstatistically selected 14 TVA sites from a population of 56 generating plants to visit and conduct walkdowns of various areas to observe potential risks related to bulk industrial gases. The selection was based on our analysis of the largest users of bulk gas for FY2012 through FY2014, identification of sites with a previous bulk gas incident history, and input from the Chief Operating Officer during the entrance conference. We selected the following fossil, gas, hydroelectric, and nuclear sites to visit:
  - Fossil Plants: Bull Run, Colbert, Gallatin (GAF), and WCF.
  - Combustion Turbine Plants: Colbert and Gallatin.
  - Hydroelectric Facilities: Blue Ridge, Cherokee, Chickamauga, Douglas, Hiwassee, and Norris.
  - Nuclear Plants: Browns Ferry and Sequoyah. (Note: As a result of these visits, we removed nuclear from our audit scope.)

We conducted this performance audit in accordance with generally accepted government auditing standards. Those standards require we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objective. We believe the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objective. The objective of this audit was not related to TVA's system of internal control; therefore, internal controls were not tested as part of this audit.

## **FINDINGS**

We determined TVA designed mitigating actions for fire, explosion and asphyxiation risks related to hydrogen, oxygen, nitrogen, and carbon dioxide bulk industrial gases. However, we identified several areas for improvement to further mitigate the risks from bulk industrial gases. Specifically, we found (1) contract terms did not require a supplier to provide TVA with inspection and maintenance reports for bulk gas tanks, (2) emergency plans do not list types and quantities of on-site gases, and (3) unsecured portable compressed gas cylinders at GAF and WCF.

## DESIGN OF MITIGATING ACTIONS ASSOCIATED WITH RISKS

We determined TVA designed mitigations to address the prevention of the risk (pre-mitigation) as well as mitigations to address the consequences of the risk occurring (post-mitigation). The mitigation strategies we identified that address risks related to hydrogen, oxygen, nitrogen, and carbon dioxide are described in Appendix A.

## AREAS FOR IMPROVEMENT

During the audit we identified several areas for improvement to further mitigate the risks from bulk industrial gases. Specifically, we found (1) contract terms did not require a supplier to provide TVA with inspection and maintenance reports for bulk gas tanks, (2) emergency plans do not list types and quantities of on-site gases, and (3) unsecured portable compressed gas cylinders at two TVA fossil plants.

### **Inspection and Maintenance Reports Not Provided to TVA**

According to Power Operations and Supply Chain personnel, TVA's largest supplier of bulk gas did not routinely provide TVA with inspection and maintenance reports for bulk gas tanks. According to the contract, the supplier is responsible for inspection and maintenance of all supplier-owned and TVA-owned bulk gas tanks located on TVA sites, excluding carbon dioxide tanks. However, the contract does not require the supplier to provide tank inspection and maintenance reports to TVA. Without the inspection and maintenance reports, TVA cannot adequately monitor tank inspections/maintenance and confirm the supplier is meeting its obligations for tank safety.

### **Emergency Plans Do Not List Types and Quantities of On-Site Gases**

We found the three fossil and three gas 2014 site emergency plans we reviewed did not include types and quantities of compressed gases and cryogenic fluids stored on-site. The National Fire Protection Association's (NFPA) 2013 edition of NFPA 55: Compressed Gases and Cryogenic Fluids Code, Section 4.2.1, requires emergency plans to include a list of the types and quantities of compressed gases and cryogenic fluids found in the facility. However, this requirement is not mandatory for facilities existing prior to June 18, 2012. While all six of the TVA sites sampled were constructed prior to this date, identification of on-site gases at all locations in accordance with NFPA 55 would be a best practice. The absence of this information could increase the risk that emergency responders would not be aware of all on-site hazards. TVA Emergency Response and Fire Protection personnel we interviewed agreed that including this information in site emergency plans is a good idea.

### **Unsecured Portable Compressed Gas Cylinders**

During site visits, we observed unsecured portable compressed cylinders at GAF and WCF. According to site personnel at GAF and WCF, suppliers have

contributed to the situation by delivering cylinders and leaving them unsecured in the storage area.

Title 29, Code of Federal Regulations §1926.350(a)(9) states:

Compressed gas cylinders shall be secured in an upright position at all times except, if necessary, for short periods of time while cylinders are actually being hoisted or carried.

According to TVA Safety and Health personnel, if a compressed gas cylinder falls or becomes damaged or cracked, the cylinder valve can break or the cylinder can rupture. As a result, high pressure gas can escape rapidly, causing the cylinder to rocket or spin out of control severely injuring people or damaging buildings and equipment.

We discussed our observations with GAF and WCF plant management and both advised they took actions during our audit to correct this issue by ordering new cylinder racks or requesting service to secure the cylinders using stronger chains. In addition, the five TVA Safety Consultants we surveyed stated they had previously observed unsecured cylinders at their assigned sites, and their concerns were corrected immediately.

## **RECOMMENDATIONS**

We recommend the Senior Vice President, Power Operations:

1. Update site emergency plans to identify types and quantities of compressed gases and cryogenic fluids stored at generating plants.
2. Assess the root cause of unsecured compressed gas cylinders at GAF and WCF and address as appropriate.

In addition, we recommend the Vice President, Supply Chain, amend gas supplier contracts to require suppliers to provide TVA with inspection and maintenance reports that (1) show contractor compliance with appropriate inspection/maintenance-related codes and regulations and (2) enable TVA to confirm the supplier is meeting its obligations for tank safety.

**TVA Management's Comments** – In response to our draft audit report, TVA management agreed with our findings and stated they have taken or plan to take the following actions on our recommendations:

- Power Operations Programs and Performance Emergency Preparedness will develop and conduct an audit of all Power Operations' facilities to identify the size, type, and location of all bulk gas storage or systems that meet the NFPA 55 definition of maximum allowable quantity. Bulk gas and cryogenic systems that meet or exceed the maximum allowable quantity will be listed in the site-specific emergency response plan.

- Power Operations Programs and Performance has collaborated with Corporate Safety to develop an Operating Experience to communicate gas cylinder requirements and risks to Power Operations' employees, increase focus on gas cylinder storage during Safety Consultant walkdowns, and record deficiencies in Transmission Operations. All occurrences not conforming to Section 3.1.7 of TVA-TSP-18.1206, Compressed Gases, will be communicated to plant management and resolved accordingly.
- Supply Chain is working with TVA's largest supplier of bulk gases to ensure TVA receives ongoing inspection reports for bulk tanks both TVA and non-TVA owned. These reports will be compiled and provided to TVA twice a year and reviewed by the Contract Technical Steward. Supply Chain will amend the vendor contract by June 30, 2016, to provide for this requirement.

See Appendix B for TVA management's complete response.

Mitigations Designed to Address Risks Related to Bulk Industrial Gases				
Mitigation Strategy	Initiatives	Mitigating Actions	Applicable Gases	Risk
Safety	TVA Safety Program (Pre/Post-Mitigation)	Provides TVA Safety Procedures to describe general safety measures, hazards and precautions for working with flammable and combustible liquids, cryogenic materials, and compressed gases.	Hydrogen, Oxygen, Nitrogen, and Carbon Dioxide	Fire, Explosion, and Asphyxiation
	Power Operations Cardinal 5 (Pre-Mitigation)	Provides expectations and guidance to employees with regard to safety observations and checklists associated with fire, explosion, and burn hazards as well as confined space entry.	Hydrogen Oxygen, Nitrogen, and Carbon Dioxide	Fire, Explosion, and Asphyxiation
	Power Operations Fire Protection Program (Pre/Post-Mitigation)	Requires inspection, testing, and maintenance of fire protection systems based on relevant National Fire Protection Association standards and defines expectations regarding storage and use of combustible and flammable materials.	Hydrogen, Oxygen, Nitrogen, and Carbon Dioxide	Fire, Explosion, and Asphyxiation
Emergency Preparedness	Power Operations Emergency Preparedness (Post-Mitigation)	Provides plans and training to prevent, prepare for, respond to, and recover from the effects of disasters including incidents involving hazardous materials.	Hydrogen and Oxygen	Fire and Explosion
Operations	Corrective Action Program (Pre/Post-Mitigation)	Promotes continuous improvement across business units. Business units are expected to find, analyze, and correct conditions that affect personnel safety, asset reliability, an adverse trend, or other condition that does not meet expectations. This may include issues related to hydrogen, nitrogen, oxygen, and carbon dioxide.	Hydrogen, Oxygen, Nitrogen, and Carbon Dioxide	Fire, Explosion, and Asphyxiation
	Operating Experiences (Pre/Post-Mitigation)	Communicate information on problem causes and corrective actions that could affect other sites.	Hydrogen, Oxygen, Nitrogen, and Carbon Dioxide	Fire, Explosion, and Asphyxiation
	River Operations Reservoir Releases Improvement Program (Pre-Mitigation)	Provides continuous monitoring of bulk liquid oxygen tanks and oxygen aeration systems used at hydroelectric facilities to improve water quality.	Oxygen	Fire and Explosion
Engineering	Power Operations Risk Reduction program (Pre-Mitigation)	Evaluate insurance risk assessment recommendations for plants to reduce risks related to carbon dioxide storage tanks, hydrogen seal oil systems, and hydrogen dryers.	Hydrogen and Carbon Dioxide	Fire, Explosion, and Asphyxiation
	Hydrogen Trailer Port Upgrades (Pre-Mitigation)	Address safety concerns on hydrogen systems.	Hydrogen	Fire and Explosion

April 6, 2016

David P. Wheeler, ET 3C-K

RESPONSE TO REQUEST FOR COMMENTS - DRAFT AUDIT 2014-15081 - TVA'S  
MITIGATION OF RISKS FROM BULK INDUSTRIAL GASES

We appreciate the opportunity to provide response on the OIG's evaluation report of TVA's Mitigation of Risks From Bulk Industrial Gases dated March 10, 2016.

**OIG Recommendations:**

We recommend the Senior Vice President, Power Operations:

1. Update site emergency response plans to identify types and quantities of compressed gases and cryogenic fluids stored at generating plants.
2. Assess the root cause of unsecured compressed gas cylinders at Gallatin Fossil Plant and Widows Creek Fossil Plant and address as appropriate.
3. Amend gas supplier contracts to require suppliers to provide TVA with inspection and maintenance reports that (1) show contractor compliance with appropriate inspection/maintenance-related codes and regulations and (2) enable TVA to confirm the supplier is meeting its obligation for tank safety.

Recommendation:

- Update site emergency response plans to identify types and quantities of compressed gases and cryogenic fluids stored at generating plants.

Response:

- Power Operations Programs and Performance Emergency Preparedness will develop and conduct an audit of all Power Operations facilities to identify the size, type, and location of all bulk gas storage or systems that meet the NFPA 55: Compressed Gases and Cryogenic Fluids Code Maximum Allowable Quantity (MAQ). Bulk gas and cryogenic systems that meet or exceed the MAQ will be listed in the site-specific emergency response plan.
- By March 1, 2017, this action will be tracked to closure using Action Tracking Item # 14472.

Recommendation:

- Assess the root cause of unsecured compressed gas cylinders at Gallatin Fossil Plant and Widows Creek Fossil Plant and address as appropriate.

David P. Wheeler  
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Response:

- Power Operations Programs and Performance has collaborated with Corporate Safety to address this recommendation. Corporate Safety will develop an Operating Experience to communicate gas cylinder requirements and risks to Power Operations employees, increase focus on gas cylinder storage during the Safety Consultants walk downs, and record deficiency in Transmission Operations.
- All occurrences discovered by Site Safety Consultants involving compressed gas cylinders not conforming to Section 3.1.7 of TSP 18.1206, Compressed Gases, will be communicated to Plant Management and resolved accordingly.


Recommendation:

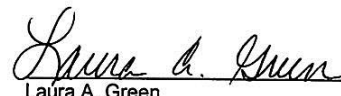
- Amend gas supplier contracts to require suppliers to provide TVA with inspection and maintenance reports that (1) show contractor compliance with appropriate inspection/maintenance-related codes and regulations and (2) enable TVA to confirm the supplier is meeting its obligation for tank safety.

Response:

- Supply Chain is working with AIRGAS to ensure TVA receives ongoing inspection reports for Bulk Tanks both TVA and non-TVA owned. The drivers visually inspect the Bulk Tanks on each delivery and will begin producing a written report of that inspection. Those reports will be compiled and provided to TVA twice a year, and reviewed by the Contract Technical Steward (CTS). Supply Chain will amend the Airgas contract by June 30, 2016, to provide for this requirement.

Please let us know if you have any other questions or need additional information.

  
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Vice President, Supply Chain  
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