Proceedings of the 18th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2016
September 18-23, 2016, Kobe, Japan

6022

WNTI Working Group on UF6 Cylinder Identification

Marc-Andre Charette
Cameco Corporation

Michael Whitaker
Oak Ridge National Laboratory

Abstract

In May 2014, the World Nuclear Transport Institute (WNTI) formed an ad-hoc working group to focus on the identification of uranium hexafluoride (UF_6) cylinders. WNTI was founded in 1998 to represent the collective interests of the nuclear transport industry, and those who rely upon the safe, secure, efficient, and reliable packaging and transport of radioactive materials. The working group scope, adopted by over 25 members, is to establish an industry-wide identification format that provide for uniquely identifying UF_6 cylinders and to investigate methods for making the unique identifier (UID) machine-readable and independently verifiable by the International Atomic Energy Agency (IAEA). The working group held multiple conference calls and two face-to-face meeting amongst its members in December 2014 and 2015, in conjunction with the WNTI semi-annual meeting in London, England. The primary focuses for 2016 are to provide a set of consensus recommendations for a preferred identification format and technology for machine readability and to participate in field testing, as needed, of key functional features.

Introduction

Industry uses standardized steel cylinders (for example Model 30B and 30C, as well as 48X, 48Y, and 48G cylinders) for storing and transporting UF_6 among many fuel cycle facilities (e.g., uranium conversion, uranium enrichment, fuel fabrication, and deconversion).[i] Given the desire to ensure that all nuclear materials are safe and secure, stakeholders of the UF_6 industry have met to identify best practices and to explore opportunities to further improve the accounting for and control of cylinders containing UF_6.

While current international transportation standards require cylinders to display a metal name plate with identification information such as owner, serial number, and certifications, the engraved information can often be difficult to read and there is not an industry standard for the format of the assigned serial number.[ii] Therefore, many companies currently add supplemental labels and markings for use at their respective facilities to improve the performance of on-site operations. The wide variety of identification formats and supplemental labels used across industry has limited the ability of the international inspectorates to be able to automate their verification activities. Industry has also identified additional operational benefits of applying a machine-readable, standardized, global identifier to each cylinder. A WNTI working group was established to identify an industry-wide identification format that provides for uniquely identifying cylinders (i.e., for 30- or 48- inch diameter) and to investigate methods for making the global identifier to be machine-readable and independently verifiable.

Background

Cylinders are exposed to a variety of operational and environmental conditions over their service life. These conditions affect the location and utilization of the cylinder ID. The facility operational practices determine where and when IDs are read.

Uranium hexafluoride is shipped and stored in standardized cylinders for processing by the conversion, enrichment, fuel fabrication, and de-conversion facilities operating in the front end of the nuclear fuel cycle. These facilities report their inventory and transfers of UF_6 to national authorities and, when required, to international agencies such as the IAEA. Since these facilities are typically not at the same location, the process for handling, processing, tracking and reporting on the nuclear material contained in these cylinders can be rather complex. Today, there are approximately 20,000 cylinders in active circulation and greater than 100,000 cylinders in long-term storage. Figure 1 below highlights the typical life cycle of both 30B and 48Y cylinders.[iii]

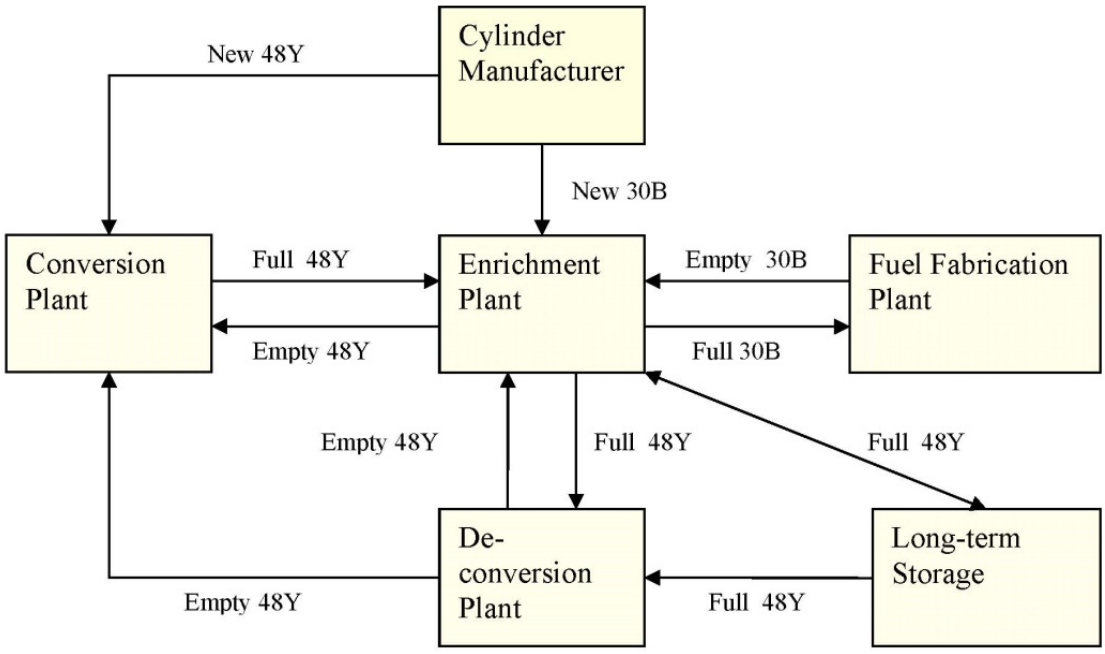

Figure 1. Typical life cycle pathways of UF6 cylinders.

Current identification practices

The cylinder fabrication standards, the International Organization for Standardization (ISO) 7195, "Nuclear energy – Packaging of uranium hexafluoride (UF_6) for transport," standard and the American National Standard Institute (ANSI) N14.1, "For Nuclear Materials – Uranium Hexafluoride Packaging for Transport," require a nameplate that includes a serial number (also referred to as a factory number). The serial numbers are provided to the cylinder fabricator by the purchaser – typically an enrichment plant or a UF_6 conversion plant or fuel

fabricator. Table 1 presents excerpts of the nameplate requirements related to cylinder identification.

Table 1: Identification requirements within the standards (ANSI & ISO) for fabrication of cylinders for handling UF6

Markings	ANSI N14.1		ISO 7195	
	30B	48X, Y or G	30B	48X, Y or G
Min Character size	5/32 inch (4 mm)	¼ inch (6.4 mm)	7 mm	7 mm
Code U stamp	Yes		Yes	
National Board number	Yes		Yes	
Owner's name or symbol	Yes		Yes	
Owner's serial number	Yes		Yes	
Manufacturer ID	Yes		Yes	
Date of Manufacturing	Yes		Yes	

Figure 2. Representative nameplate welded to the end of a cylinder.

The identification information applied to the nameplates, Figure 2, is often difficult to read due to the small size of the lettering and the lack of contrast between the engraved letters and the metal background. While the combination of markings (names, dates, certifications) make the entire nameplate unique, the standards do not require a standard format for the serial numbers and do not provide a means to prevent different companies from using the same numbers.

Identification Formats

The cylinder identification is a combination of letters and numbers provided by the purchaser to the cylinder fabricator to be engraved on the nameplate. Once stamped or engraved, the identification number typically remains unchanged over the entire lifetime of the cylinders which can extend 50 years or longer. Occasionally, an identification number may be changed if a cylinder is sold and the new owner desires a new number with a

different format.

These identification formats can vary widely across industry as each company will establish its own specific format. Even within a company, the format may change over time as companies change their names, revise their format, or change their practices. Some companies have reported that they are managing four or more "standard" formats for their cylinders. Even if each company establishes its own standardized format for identification of new UF_6 cylinders, it's entire cylinder fleet might contain multiple formats due to the presence of legacy cylinders.

The members of the WNTI working group on UF_6 cylinder identification have reported the following formats being used on cylinders in active circulation or in long-term storage yards, this list is not intended to be a complete list of all formats used:

Table 2: Examples of cylinder identification formats currently used by the industry

- 1122 nnnn - 1127 nnnn - Aaa nnn - AC nnnn - CAM nnnn - CE nnnn - COG nnnnn - EURO nnnnn - GEWnnn	- HON nnnn - JMnnn - SAE nnnn - ST nnnnn - SKB nnnn - TC-nnnn - TY-nnnn - UREUnnnnnn
Note: "**a**" represents a letter and "**n**" represents a number	

The multiplicity of formats used for identifying new and legacy cylinders can pose a challenge to accurate, timely and cost-efficient reading and recording of the numbers. For example, in the past many formats used spaces, periods, or dashes. In addition, often it can be difficult to distinguish between similar numbers and letters such as "0" and "O", "5" and "S", "1" and "I", etc. As discussed below, some operators have resorted to using supplemental labels for facilitating identifying cylinders at their facilities. Similarly many cylinder identification numbers include use a variety of period (.), dashes (-_) and spaces in the sequence.

Supplemental Company Cylinder Identifiers

Because the cylinder identification can be difficult to read. even from short distances away, many companies currently add a supplemental cylinder identifier for use at their respective facilities to improve the performance of on-site operations. The supplemental cylinder identifiers are applied with a variety of techniques including marking, stencilling, adhesive labels, paint markings, and stickers. These identifiers may use the serial number stamped on the nameplate or they can contain a different number created by the company. Some of these identifiers may contain a feature that provides for the identification to be read by automated methods (e.g., bar code, RFID, etc.). Figures 3 and 4 show industry applied stencils and barcode stickers.

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Figure 3. Company applied stencil.

Figure 4. Company applied sticker containing a 1D barcode.

Supplemental cylinder identifiers generally vary in style and format between companies such that an identifier applied by one company cannot be used by other companies. As a cylinder travels between multiple facilities over its service life, it can accumulate a variety of different types of marking and labels. While these supplemental identifiers are effective in supporting domestic reporting requirements, they often cannot be used for international reporting because they are not permanently applied.

Operational Practices

Cylinder Identification Activities

The operational need exists to be able to correctly identify cylinders as they are stored, moved and processed on-site, and transported between facilities. The capability to correctly identify cylinders during their processing and storage at fuel cycle facilities is extremely important for:

- meeting regulatory reporting requirements
- ensuring compliance with nuclear safety requirements
- providing traceability for filling customer orders

- managing cylinder inventories and cylinder transactions such as sales or loans of cylinders to another operator or customer
- supporting data bases that contain cylinder information and conditions to ensure that only compliant cylinders are placed in use
- facilitating compliance with national nuclear material control and international nuclear material safeguards requirements

To identify the cylinders, individual facility operators may use the serial number engraved on the nameplate or use their company supplemental identifier.

Compatibility with Existing Enterprise Reporting Systems

Whether manually reading and recording the cylinder serial number engraved on the nameplate or reading the supplemental company identifiers (manually or automatically), companies align the cylinder identification with other important information in the facility data bases. This information may include, but is not limited to:

- Gross weight of the cylinder and its contents from accountability scales or process scales
- The isotopic enrichment of the uranium contained in the cylinder from destructive analysis, nondestructive assay measurements, or process measurements,
- History of cylinder certification information such as last Hydro-Test Date, and
- Other pertinent information such as recertification date, tare weights, cylinder owner, cylinder inspection reports, etc.

Data bases are maintained to allow the operator to coordinate the information contained on the additional nameplate or marking device and the official number utilized for tracking the cylinder. The three types of numbers typically seen on the nameplates are:

- the Manufacturer’s serial number,
- the Owner’s serial number, and
- the National board registration number.

In addition to the utilization of the nameplate number for regulatory reporting, the operators of the facility may utilize the information in their:

- Nuclear Material Control and Accountancy (NMC&A) System
- Production Planning/Order Management System
- Cylinder Management and Compliant-Cylinder Monitoring System

Operators maintain enterprise reporting and management information systems that fulfil these functions and utilize cylinder information of the sort identified here. An industry standard format for cylinder identification should be compatible with these enterprise management systems, or compatible with minimal modification of these systems.

Current work on a preferred global identifier

Although the existing UF_6 cylinder numbering system has proven to be adequate for the logistics operations within the supply chain of UF_6, it is recognized that the following improvements may be achievable if an industry-wide and unique identifier for UF_6 cylinders is implemented:

- All enterprise reporting systems within the supply chain using the same UF_6 cylinder identifier
- All transport documentation within the supply chain using the same UF_6 cylinder identifier
- Improved communication within the supply chain between consignor, consignee, transport agent, carriers, port authorities, customs, etc.
- Improved tracing of UF_6 cylinders within the supply chain
- More efficient safeguard operation for the verification of UF_6 cylinders

Given the desire to achieve these potential improvements and ensure that all nuclear materials are safe and secure, stakeholders of the UF_6 industry have met to identify best practices and to explore opportunities to further improve the accounting for and control of cylinders containing UF_6. Among the benefits foreseen are:

- Eliminate difficulty in reading current nameplate information - would eliminate reading and transcription errors
- Could reduce time for conducting inventories of on-site cylinders
- Provide capabilities for companies to better integrate data systems involving cylinder-related information
- Could provide for inspectorates to automate inspection activities
- Companies could eventually migrate towards using the global identifier and not have to apply supplemental labels
- Improve consistency of reporting across the industry
- Could improve reconciliation of transactions between facilities – both shippers and received could refer to the same cylinder identification number.

Recommended requirements

A common set of functional and performance requirements can be specified for designing a global identifier including:

- A standardized lettering/numbering format/design
- A numbering/lettering scheme that is not duplicated across industry
- An ID large enough to be visually read from a reasonable distance
- Capability to be remotely read (i.e., machine readable)
- Capability to withstand all the environment conditions in transport and use.
- Must withstand the environmental conditions and operating practices.
- Identifier lifetime that would last the entire cylinder life cycle, which typically extends 30-40 years and in some cases longer.

- Reasonable application and maintenance costs.
- Compliance with the requirements of the IAEA and EURATOM.

Additional features could enable the international inspectorates (e.g., IAEA, EURATOM, etc.) to fully take advantage of the identifier for safeguards purposes.

- The identifier would need to be applied in a tamper-indicating manner.
- There needs to be a characteristic of the identifier (e.g., a unique weld seam of a plate containing the identifier) to enable them to authenticate its authenticity.

The IAEA has determined that unique identifiers with tamper indicating features would provide them the opportunity to improve the effectiveness and efficiency of verification activities at both the facility and state levels, and that the benefits of these identifiers could be realized incrementally through-out a longer-term implementation process.[iv]

Preferably, the global identifier would be installed on new cylinders during the fabrication process prior to cylinder certification. Given that there are over 20,000 cylinders in active service, it would also be advantageous if the identifier could be installed on existing cylinders either in the field or during the re-certification process.

Conclusions

Industry adoption of a cylinder identification scheme might provide new opportunities to enhance the efficiency and effectiveness of international safeguards. Development of a unified standard for container manufacturers regarding application of a serial (manufacturer's) number could yield a positive economic effect as a result of reducing the reading errors, computerized reading and applying a unique identification number to exclude repeated numbers.

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