

Assessment of vapor containment of the BD PhaSeal™ Optima System

Introduction

Closed-system drug transfer devices (CSTDs) have been adopted throughout the world to reduce the risk of hazardous drug exposure during the preparation, administration, storage and transport of hazardous drugs. The National Institute of Occupational Safety and Health (NIOSH) defines a CSTD as: “a drug transfer device that prevents the transfer of environmental contaminants into the system, and the escape of hazardous drug vapors or concentrations outside the system.”¹ In 2007, the International Society of Oncology Pharmacy Practice (ISOPP) further characterized that a CSTD should be “airtight and leakproof (*p. 29*).”² As of today, there are no performance standards to establish how a system may meet the definition of a CSTD, so each manufacturer may develop its own assessments. In the United States, the Food and Drug Administration (FDA) established a specific product classification code, ONB, to identify “Closed Antineoplastic and Hazardous Drug Reconstitution and Transfer Systems” defined as a system that will

“reconstitute and transfer antineoplastic and other hazardous drugs in healthcare setting indicated to reduce exposure of healthcare personnel to chemotherapy agents in healthcare setting.” The establishment of this code was for classification only—the FDA did not establish required tests or performance standards for this code. Each manufacturer continues to determine its own test methods.

In response to requests from industry and customers to develop a standardized method of testing CSTDs, NIOSH researchers developed a draft protocol to evaluate the containment performance of CSTDs that use a physical barrier to reduce the risk of hazardous drug exposure. They believed the draft protocol “could have multiple applications and could be used by manufacturers to evaluate prototype CSTDs, by consumers to compare CSTD products, or by jurisdictions wishing to adopt the protocol for a CSTD performance certification procedure.”³ Once an initial

draft was developed, the NIOSH team asked pharmacists familiar with the use of CSTDs to validate the protocol, engaged a panel of peer reviewers and key stakeholders to review and provide comments, and then published the final draft of the protocol for public comment in September 2015 in CDC-2015-0075 and Docket Number NIOSH-288 in accordance with NIOSH procedure.

The BD PhaSeal™ Optima system, a new CSTD built on the foundation of the BD PhaSeal™ system, retains the architecture of the BD PhaSeal system and utilizes the same physical barrier technology to prevent exposure—a vapor-capturing mechanism in the protector component that is assembled to the vial, and membrane-to-membrane connections that self-seal upon disconnect to enable airtight, leakproof transfers (*Figure 1*).



Assessment of BD PhaSeal Optima System vapor containment performance

Methods

The NIOSH draft vapor containment protocol consists of two tasks that are intended to utilize multiple components of the CSTD system. Task 1 mimics reconstitution of a hazardous drug for IV infusion. Task 2 simulates preparation and administration of an IV syringe push. All tasks are performed with 70% isopropyl alcohol (IPA) in a specially constructed closed chamber (*Figure 2*). In place of actual drug, 70% IPA is used as a challenge agent, and a highly specific gas analyzer, the Thermo Scientific™ MIRAN SapphIRe XL Infrared Analyzer, is used to quantify the amount of IPA released into the test environment during each step of the procedure. Because IPA is highly volatile, this test is designed to enable real-time detection of vapor, aerosols or liquid that may leak from the system. The limit of detection (LOD) of this equipment is 0.30 ppm. The threshold of the test is set at 3.33 times the LOD, or 1.0 ppm. Readings below 1.0 ppm represent successful vapor containment.

A high-level overview of each task is shown below. Through the execution of the steps outlined in each task, each CSTD component is used per the manufacturer's Instructions for Use in an attempt to replicate actual use conditions for hazardous drug transfer with the CSTD. Between each key transfer step, there is a pause to allow the IPA detector to stabilize and to allow any released IPA to dissipate below the detection limit before starting the next step.

The BD PhaSeal Optima system was tested for the following tasks, two of which are described in the NIOSH draft vapor containment protocol. The additional tasks were developed

by BD to evaluate performance in additional use cases. During each task, the IPA concentration was measured and recorded continuously:

- 1 Preparation of an IV bag using two syringes each with a BD PhaSeal Optima Injector N35-O, two 20-mm vials each with a BD PhaSeal Optima Protector P20-O and one IV bag with a BD PhaSeal Optima Infusion Adapter C100-O
- 2 Preparation and administration of an IV push using two syringes each with a BD PhaSeal Optima Injector N35-O, two 20-mm vials each with a BD PhaSeal Optima Protector P20-O and one y-site with a BD PhaSeal Optima Connector C35-O
- 3 Preparation of an IV bag using two syringes each with a BD PhaSeal Optima Injector N35-O, two 13-mm vials each with a BD PhaSeal Optima Protector P13-O and one IV bag with a BD PhaSeal Optima Infusion Adapter C100-O
- 4 Administration of a 24-hour IV infusion using two IV bags each with a BD PhaSeal Optima Infusion Adapter C100-O, one IV line with a BD PhaSeal Optima Injector N35-O and one y-site with a BD PhaSeal Optima Connector C35-O
- 5 Ten (10) punctures of the membrane using one 20-mm vial with a BD PhaSeal Optima Protector P20-O and one syringe with a BD PhaSeal Optima Injector N35-O

Each scenario was repeated four times.



Figure 1 The BD PhaSeal Optima System



Figure 2 Sealed environmental test chamber for assessment of vapor containment.



Figure 3 Thermo Scientific MIRAN SapphIRe analyzer.

Results

Results of testing for each task are shown in the table below.

Replicate	Maximum BG-0 _{max} values (ppm)				
	Task 1: Preparation of an IV bag with 20-mm vials	Task 2: Preparation and administration of an IV push	Task 3: Preparation of an IV bag with 13-mm vials	Task 4: Administration of a 24-hour IV infusion	Task 5: Ten (10) punctures of a 20-mm vial [†]
1	0.2 (0.3*)	0.2 (0.3*)	0.4	0.3	0.9
2	0.0 (0.3*)	0.0 (0.3*)	0.0 (0.3*)	0.2 (0.3*)	0.5
3	0.7	0.2 (0.3*)	0.4	0.1 (0.3*)	0.3
4	0.5	0.7	0.0 (0.3*)	0.1 (0.3*)	0.1 (0.3*)
Mean for task performance	0.35 (0.45*)	0.28 (0.40*)	0.2 (0.35*)	0.2 (0.3*)	0.45 (0.5*)

*As per the draft NIOSH Vapor Containment Protocol, the test values less than the limit of detection, i.e., 0.3, are reassigned to 0.3.

[†]The Task 5 column shows the test values of the maximum IPA reading among 10 successive penetrations, i.e., the maximum BG-0_{max} values in the chamber after the tenth penetration (ppm), where the BG-0_{max} value was recorded before the first penetration.

For each task, all replicates tested resulted in a detected concentration of IPA lower than the 1.0 ppm threshold of the vapor containment test.

Conclusion

The BD PhaSeal Optima system meets the requirements set forward in the NIOSH draft vapor containment protocol for successful containment of a stressful challenge agent in various use scenarios.

References

- 1 Centers for Disease Control and Prevention. Preventing Occupational Exposures to Antineoplastic and Other Hazardous Drugs in Health Care Settings. NIOSH Alert 2004-165. Available at <https://www.cdc.gov/niosh/docs/2004-165/pdfs/2004-165.pdf?id=10.26616/NIOSH-PUB2004165>. Published September 2004. Accessed August 22, 2018.
- 2 International Society of Oncology Pharmacy Practitioners Standards Committee. ISOPP standards of practice. Safe handling of cytotoxics. *J Oncol Pharm Pract.* 2007;13(Suppl):1-81.
- 3 Centers for Disease Control and Prevention. A vapor containment performance protocol for closed system transfer devices used during pharmacy compounding and administration of hazardous drugs. NIOSH Docket Number 288; CDC-2015-0075-0003. Available at <https://www.cdc.gov/niosh/docket/review/docket288/default.html>. Last reviewed August 26, 2015. Accessed August 22, 2018.

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