UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

This document has been electronically approved and signed.

BALLOT VOTE SHEET

DATE: May 20, 2020

TO: The Commission
Alberta E. Mills, Secretary

THROUGH: Mary T. Boyle, Executive Director
John G. Mullan, General Counsel

FROM: Hyun S. Kim, Acting Assistant General Counsel
Barbara E. Little, Attorney, OGC

SUBJECT: Petition VGBA 19-1; Petition for Classification of "Vacuum Diffusion Technology" as an Anti-Entrapment System Under the Virginia Graeme Baker Pool and Spa Safety Act

BALLOT VOTE Due: Wednesday, May 27, 2020

CPSC staff is forwarding a briefing package to the Commission regarding a petition submitted by PSD Industries, LLC (PSD Industries), requesting that the CPSC classify vacuum diffusion technology (VDT) as an anti-entrapment device or system under the Virginia Graeme Baker Pool and Spa Safety Act (VGBA). PSD Industries submitted a previous petition with the same request (VGBA 15-1). On March 25, 2016, the Commission voted unanimously (5-0) to deny petition VGBA 15-1. The resubmitted petition contains additional information. In the attached briefing package, staff recommends that the Commission deny the petition.

Please indicate your vote below:

I. Grant the petition and direct staff to begin developing a notice of proposed rulemaking.

_____ _____
(Signature) (Date)

II. Defer the petition.

_____ _____
(Signature) (Date)

III. Deny the petition and direct the staff to submit the draft denial letter for a vote by the Commission.

_____ _____
(Signature) (Date)

IV. Take other action (please specify).

_____

_____

_____

_____ _____
(Signature) (Date)

Attachment: Staff briefing package: Vacuum Diffusion Technology Petition

Staff Briefing Package

2019 Vacuum Diffusion Technology Petition

May 20, 2020

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Executive Summary

On August 27, 2019, PSD Industries LLC (PSD, or petitioner), submitted a petition (VGBA 19-1) to the U.S. Consumer Product Safety Commission (Commission, CPSC) to approve Vacuum Diffusion Technology (VDT) as an anti-entrapment device or system within the "other system" category of the Virginia Graeme Baker Pool and Spa Safety Act (Act, VGBA). The petitioner's product, the ProteKtor,™ is an example of VDT. The petitioner previously submitted petition VGBA 15-1 in 2015. The 2019 petition contains additional information and assertions, but makes the same request as set forth in the 2015 petition. The Commission denied Petition VGBA 15-1, because the product did not provide body entrapment protection and did not demonstrate protection against hair or mechanical entrapments.

The VGBA requires that public pools with a single main drain other than an unblockable drain be equipped with one or more of five enumerated devices or systems, or "other systems," that are designed to prevent suction entrapment. The five enumerated systems and the "other system" category are also known as "secondary systems." The VGBA defines "other systems" as "any other system determined by the Commission to be equally effective as, or better than, the [five systems in the VGBA] at preventing or eliminating the risk of injury or death associated with pool drainage systems." To be deemed an "other system," the VGBA requires that the ProteKtor™ be equally effective, or better than, the secondary systems enumerated in the Act.

The secondary systems are designed to protect against entrapment. There are five recognized types of entrapment hazards associated with pool drains and pool drain covers. These are body entrapment, limb entrapment, hair entrapment, mechanical entrapment, and evisceration.

The resubmitted petition includes new claims and assertions, as well as new testing and supporting documentation. After reviewing the contents of the petition, including the definition of VDT provided by the petitioner, the ProteKtor™ as a physical example of VDT, and three technical reports, staff determined that VDT/ProteKtor™ may protect against limb entrapment, but it may not protect against hair or mechanical entrapment. Staff is also concerned that the ProteKtor™ may introduce new hair and mechanical entrapment hazards in the drain sump, if this device is installed. Furthermore, as acknowledged by PSD, staff's review concludes that VDT/ProteKtor™ does not protect against body entrapment; it also does not protect against evisceration.

The VGBA emphasizes protection against body entrapment, which is the most commonly reported entrapment hazard for pool circulation-related incidents within the scope of the VGBA. The five enumerated systems and the drain cover requirements in the VGBA all provide body entrapment protection. Staff reviewed available incident data and found body entrapment to be the most significant entrapment hazard within the scope of the VGBA. For this reason, staff believes that to be deemed equally effective as the five enumerated systems in the VGBA, and thus, to be considered a secondary system under the Act, VDT/ProteKtor™ must provide protection against body entrapment.

Staff concludes that VDT/ProteKtor™ does not protect against body entrapment and may not protect against hair or mechanical entrapment. Staff also concludes that VDT/ProteKtor™ may

introduce new hair or mechanical entrapments. Therefore, staff determined that VDT/ProteKtor™ is not equally effective as the secondary systems at reducing entrapments in drains and does not meet the requirements to be approved as an "other system" under the VGBA. Based on the analysis presented in this package, staff therefore recommends that the Commission deny petition VGBA 19-1.

Staff notes that, although staff does not agree with the petitioner that VDT and the ProteKtor,™ as an example of VDT, are equally as effective or better than the enumerated systems in the Act, staff does agree that this technology may provide some level of entrapment protection, if used in addition to the secondary systems listed in the VGBA. Nothing in the Act prohibits the use of VDT or the ProteKtor™ in addition to one of the enumerated secondary systems in the Act. Moreover, staff encourages the continued development of this type of innovation and new technology.

Briefing Memo

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MARYLAND 20814

Memorandum

Date: May 20, 2020

TO: The Commission
Alberta E. Mills, Secretary

THROUGH: John G. Mullan, General Counsel
Mary T. Boyle, Executive Director

J. DeWane Ray, Deputy Executive Director for Safety Operations

FROM: Duane Boniface, Assistant Executive Director
Office of Hazard Identification and Reduction

Matthew J. Brookman P.E., PMP, Project Manager
Division of Mechanical Engineering, Directorate for Laboratory Sciences

SUBJECT: 2019 Vacuum Diffusion Technology Petition Briefing Package

I. Introduction

The Virginia Graeme Baker Pool and Spa Safety Act (Act, VGBA) requires public pools with a single main drain other than an unblockable drain to be equipped with one or more of five enumerated devices or systems that are designed to prevent suction entrapment. These devices or systems are also known as "secondary systems."

The Act also directs the U.S. Consumer Product Safety Commission (Commission, or CPSC) to allow "other systems" as a means of compliance with the VGBA, if they are "determined by the Commission to be equally effective as, or better than, the [five systems enumerated in the VGBA] at preventing or eliminating the risk of injury or death associated with pool drainage systems." In petition VGBA 19-1, PSD Industries LLC (petitioner), seeks to have "vacuum diffusion technology" (VDT), and the ProteKtor,™ as an example of VDT, included as an "other system." If determined to be an "other system," a VDT-based product, such as the ProteKtor,™

could be installed in a single blockable drain, in lieu of the five specified systems, to comply with the requirements of the Act.

The petitioner previously submitted petition VGBA 15-1 in 2015. The 2019 petition contains additional information and assertions, but makes the same request as set forth in the 2015 petition. The Commission denied Petition VGBA 15-1, because the product did not provide body entrapment protection and did not demonstrate protection against hair or mechanical entrapments.

II. Background

A. Pool and Spa Drain Related Hazards

There are five recognized types of hazards associated with pool drains and pool drain covers. The following is a list and brief description of each hazard.

Hair Entrapment – Occurs when water flowing into the drain from the pool carries a person's hair through and behind the openings in the cover, where it becomes sufficiently entangled to prevent escape.

Body Entrapment – Occurs when a person is held against the pool wall or floor, due to the suction of the pool circulation system.

Limb Entrapment – Occurs when a cover is broken and a person gets a limb stuck in the broken portion of the cover, or when a cover is completely missing and a person gets a limb wedged in the suction outlet[1] that is within the pool drain sump.

Mechanical Entrapment – Occurs when something that the bather is wearing, *e.g.*, an ear ring, or a swimsuit with knotted strings, becomes physically wedged into the drain cover.

Evisceration – A suction-induced disembowelment, which typically occurs to children who sit on drains. Often, the victim initially survives the disembowelment but subsequently dies of injuries related to the incident.

[1] The "suction outlet" is the orifice where the water being drawn from the pool by the pump leaves the sump of the suction outlet fitting assembly (SOFA).

B. Virginia Graeme Baker Pool and Spa Safety Act

Section 1404 of the Act concerns the installation of devices intended to prevent entrapment by pool drains. Section 1404 states:

> a) each public pool and spa in the United States shall be equipped with anti-entrapment devices or systems that comply with the ASME/ANSI A112.19.8[2] performance standard, or any successor standard; and
> b) each public pool and spa in the United States with a single main drain other than an unblockable drain shall be equipped, at a minimum, with one or more of the following devices or systems designed to prevent entrapment by pool or spa drains:
>
> (I) SAFETY VACUUM RELEASE SYSTEM.—A safety vacuum release system which ceases operation of the pump, reverses the circulation flow, or otherwise provides a vacuum release at a suction outlet when a blockage is detected, that has been tested by an independent third party and found to conform to ASME/ANSI standard A112.19.17 or AS™ standard F2387.
> (II) SUCTION-LIMITING VENT SYSTEM.—A suction-limiting vent system with a tamper-resistant atmospheric opening.
> (III) GRAVITY DRAINAGE SYSTEM.—A gravity drainage system that utilizes a collector tank.
> (IV) AUTOMATIC PUMP SHUT-OFF SYSTEM.—An automatic pump shut-off system.
> (V) DRAIN DISABLEMENT.—A device or system that disables the drain.
> (VI) OTHER SYSTEMS.—Any other system determined by the Commission to be equally effective as, or better than, the systems described in subclauses (I) through (V) of this clause at preventing or eliminating the risk of injury or death associated with pool drainage systems.

After the VGBA went into effect on December 19, 2008, based on incidents reported to CPSC, the rate of body entrapments dropped by 50 percent, and limb entrapment incidents dropped by more than 80 percent. These statistics are based on incident data from 1995 to 2019. The Act is effectively reducing the number of entrapment incidents.

The petitioner requests that the Commission determine that VDT/ProteKtor™ is "equally effective as, or better than, the systems described in sub-clauses (I) through (V) [of the Act] at preventing or eliminating the risk of injury or death associated with pool drainage systems."

[2] The currently approved successor standard is APSP-16, 2017, Suction Outlet Fitting Assemblies (SOFA) for Use in Pools, Spas, and Hot Tubs."

C. Vacuum Diffusion Technology

The petitioner defines "VDT" as:

> *A system that removes the intense vacuum draw from the intake point of a pumping system by occluding the intake orifice from swimmers and diffusing the vacuum from a potential blockage immediately in multiple directions from the blockage. To be considered Vacuum Diffusion Technology, covering 50% of the Vacuum Diffusion Technology intake should not raise the normal vacuum draw by more than .4" Hg. Vacuum Diffusion Technology devices must automatically adjust to changing conditions in the system in which it is installed, cannot be by-passed, require no calibration and contain no electronics or moving parts to malfunction.*

The petitioner developed the definition of "VDT." The petitioner's product, the ProteKtor,™ is an example of VDT. This device, which is commercially available, is placed over the suction outlet within a drain sump. It consists of a perforated shell with an end piece that fits into a pipe. The perforated shell is affixed to the end piece and covers the orifice of the suction outlet. This device, when installed properly, is intended to fit beneath the drain cover. FIGURE 1 is an image of the ProteKtor,™ and FIGURE 2 is a rendering of the device installed in a drain sump.[3]

Figure 1. The ProteKtor Vacuum Diffuser System™

[3] http://www.psdindustries.com/product-manual.pdf.

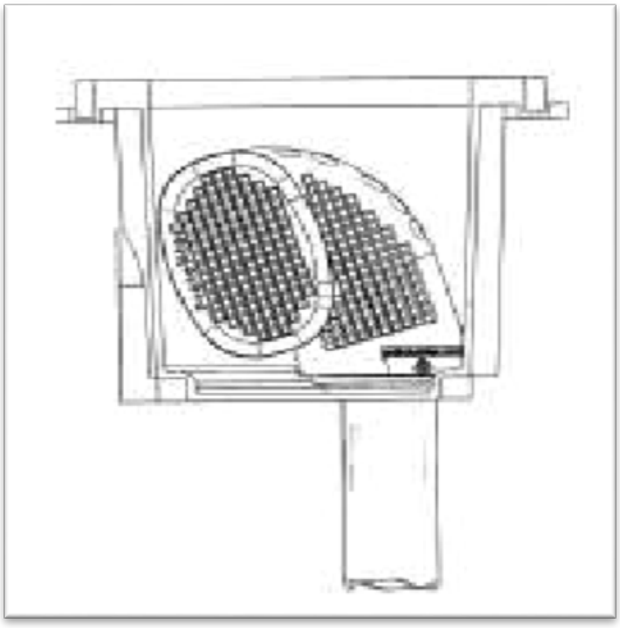


Figure 2. The ProteKtor™ installed in a drain sump

D. Petition History

1. VGBA 15-1

On June 23, 2015, PSD Industries submitted a petition[4] (VGBA 15-1) for CPSC to approve VDT/ProteKtor™ as an anti-entrapment device or system within the "other systems" category of the VGBA. Based on the analysis described below, staff recommended denying petition VGBA 15-1. In 2016, the Commission denied the petition. The Commission determined that VDT and the ProteKtor™ did not meet the requirements to be approved as an "other system," primarily because the device failed to protect against body entrapment, and because it could introduce new hair, limb, and mechanical entrapment scenarios.

In staff's analysis of the VGBA 15-1 petition, staff determined that the VGBA emphasizes protection against body entrapment. Each of the five enumerated secondary systems protects against body entrapment. The Act's requirements for drain covers enhance body entrapment protection. Unblockable drains are excluded from the requirement of a secondary system because they are too large for a human body to create a suction entrapment hazard and do not present a body entrapment hazard.

The petitioner acknowledged, and staff confirmed that the ProteKtor™ does not protect against body entrapment. In addition, staff also determined that VDT/ProteKtor™ would not protect against evisceration because this hazard is created by the development of a seal formed by the body against the drain in the same way as body entrapment.

[4] Petition to Commissioners of the Consumer Product Safety Commission to include "Vacuum Diffusion Technology" in the "Other Systems" category of the Virginia Graeme Baker Pool and Spa Safety Act, Paul C. McKain/CEO- PSD Industries, LLC, 6/11/2015.

Staff concluded that due to the broad definition of "VDT" proposed by the petitioner, the characteristics of the ProteKtor,™ as an example of VDT, and the lack of any standards governing the design, installation, or operation of this technology, staff could not assess whether that VDT would even prevent hair or mechanical entrapment hazards.

Staff also found that VDT/ProteKtor™ may introduce new hazard patterns when installed under drain covers. When a drain cover is missing, VDT/ProteKtor™ presented new obstructions within the sump that could create hair, mechanical, or limb entrapment hazards where none existed before. Hair and mechanical entrapment hazards typically only exist when interfacing with the drain cover. With VDT installed, this hazard also existed when the drain cover was missing.

2. VGBA 19-1

On August 27, 2019, PSD Industries resubmitted the petition[5] (VGBA 19-1) with the same request as the 2015 petition, with additional information. The petitioner makes the same arguments in support of the use of VDT/ProteKtor™ as an anti-entrapment device or system within the "other system" category of the VGBA and provides additional documentation. Some of the information provided by the petitioner in VGBA 19-1 is identical to the information provided in VGBA 15-1. This includes the petitioner's definition of "VDT," claims regarding the deficiencies of the five enumerated systems, and the petitioner's claimed benefits of VDT.

For VGBA 19-1, in addition to reiterating the information provided in VGBA 15-1, the petitioner provided the following:

- Responses to issues identified in the VGBA 15-1 briefing package;
- Letters of support for Commission approval from the Association of Pool and Spa Professionals (APSP) and Stingl Safety Consulting;
- Three technical reports; and
- A copy of the Brazil CSSF Pool Safety Bill.

Petitioner rejects staff's interpretation that body entrapment protection is a necessary requirement for an "other system." Petitioner also claims that the ProteKtor™ effectively eliminates the preponderance of the known entrapments that exist today.

The three technical reports in VGBA 19-1 include one from the University of Denver and two from Penn State University. The University of Denver report, "Device Performance Study of a Modified Suction Outlet in Pools and Spas," presents research on the flow fields created by sump drains. One of the Penn State reports, "Preliminary Draft PSD Flow Adapter Flow Studies," discusses pump noise and flow rate changes created by the ProteKtor.™ The other Penn State report, "Test Report: ProteKtor Test Recording and Documentation," provides test results related to the ProteKtor's™ ability to prevent limb entrapment and hair or mechanical entanglement.

[5] Federal Petition to the Consumer Product Safety Commission to Approve Vacuum Diffusion Technology as an "Other System" under the Virginia Graeme Pool and Spa Safety Act, Paul C. McKain, PSD Industries, LLC, 8/27/2019

III. Summary of the Technical Evaluation

Staff reviewed the resubmitted petition and its attachments. The technical evaluation is discussed in Tab A. Specifically, staff reviewed the definition of "VDT," the petitioner's claims and assertions, and submitted reports. Following is a summary of staff's review.

A. Discussion of the Petition

1. Hair and Mechanical Entrapment Protection

The petitioner's definition of "VDT" describes a technology that distributes vacuum pressure to prevent the pressure from exceeding a specified limit when the device is partially blocked. The definition describes a system similar to a drain cover and does not mention any specific entrapment protections. The petitioner provides the ProteKtor™ as an example of VDT and describes the ProteKtor™ as a device similar to a drain cover. However, the ProteKtor™ is designed to cover the opening of a sump pipe, while a pool drain cover is designed to cover the top of the drain sump. Drain covers undergo extensive testing for hair, limb, and body entrapment per ANSI/APSP-16, *Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs*. Currently, there are no standards governing the design, installation, or operation of VDT or the ProteKtor.™ Because the ProteKtor™ essentially serves as a drain cover intended to be placed over the opening of the sump pipe, staff believes that it may afford some protection against limb entrapment when the pool drain cover over the sump is missing. However, hair and mechanical entrapment appear to be more likely when the drain cover is missing and the ProteKtor™ is present in the sump. This device presents additional obstructions that hair or other objects could become entangled against where no obstructions previously existed.

2. Body Entrapment Protection

The petitioner disagrees with the Commission's determination regarding the VGBA 15-1 petition that body entrapment protection is a requirement of the VGBA. In the VGBA 19-1 petition, PSD does not include a system that provides body entrapment protection. The VGBA requires that an "other system" must be at least equal to the secondary systems enumerated in the Act. All of the systems enumerated in the Act provide body entrapment protection. Body entrapment and evisceration occur on the drain cover or on the top of the sump when the drain cover is missing. VGBA-compliant drain covers, used in conjunction with one of the enumerated secondary systems, provide body entrapment protection when a bather contacts the drain regardless of whether the cover is in place or missing.

As discussed, although the VDT/ProteKtor™ may prevent limb entrapments when the drain cover is off because the device is placed over the suction outlet within a drain sump, it will not prevent body entrapment when the drain cover is off. The VDT/ProteKtor™ does not provide body entrapment protection because it cannot limit the suction entrapment forces at the opening of the sump, and therefore, the device cannot protect against body entrapment or evisceration. If VDT and the ProteKtor™ were approved as an "other system," as an alternative to the five systems specified in the Act, the Commission would be permitting a system that would not protect against body entrapment and that could potentially cause hair and mechanical

obstructions.[6] Staff did not find persuasive information in the resubmitted petition to change staff's conclusion that a secondary system, to be effective, must provide protection against body entrapment.

3. Potential for ProteKtor™ to Be Bypassed

The petitioner also claims that VDT is superior to other secondary systems because it requires tools to remove the device and cannot be bypassed. Staff acknowledges that the requirement of a tool can prevent unauthorized removal. However, staff is concerned that a single screw is used to secure the ProteKtor™ to the suction outlet. Staff believes that the ProteKtor™ can be bypassed because it can be removed. For instance, the ProteKtor™ can be bypassed during seasonal or unscheduled maintenance, if it is removed from the sump pipe and is not reinstalled, or is reinstalled improperly.

4. Effects of Variable Speed Pumps and Flow Changes

The petitioner claims that VDT functions with all variable speed pumps, while suction vacuum release systems (SVRS- one of the enumerated systems) do not. The petitioner claims that when new Department of Energy regulations for the energy efficiency of 1 to 5 horsepower pool pumps become effective in 2021, the regulations will place performance demands such that only variable speed pumps will be able to comply. An SVRS provides body entrapment protection by releasing water pressure a few seconds after an entrapment occurs. Staff agrees that certain SVRSs would not work effectively with certain uses of variable speed pumps. A variable speed pump would present calibration issues for an SVRS if the speed was changed often, but would not present this issue if the pump speed was set to a precise water flow. APSP-17,[7] a proposed standard for SVRS devices, is currently in draft form. The petitioner notes that this standard may be updated to address variable speed pumps, by including testing at varying speeds. SVRS manufacturers are expected to respond by making improvements or creating new products to comply with the new tests, so that SVRSs will be able to function with variable speed pumps.

The ProteKtor™ is similar to a drain cover because it is a passive system that covers an outlet, and its performance is affected by the water flow rate. A passive secondary system lacks the ability to adjust to changing entrapment conditions. Any entrapment protection with the VDT/ProteKtor™ depends on flow rate, including the varying flow rates from using variable speed pumps and changes made to a fixed speed pump system. Standard testing for drain covers sets a maximum flow rate specified for their use based on hair and body entrapment forces. If this flow rate is exceeded, the forces will be higher and the safety provided by the original drain cover installation will be compromised. This condition applies to the ProteKtor,™ as well because, similar to a drain cover, it is passive, and the entrapment forces will increase with rising water flow rates. However, unlike drain covers, there are no standards governing the design, installation, or operation requirements for VDT/ProteKtor.™ This makes the entrapment performance of the VDT/ProteKtor™ variable and dependent on the particular pool or spa system in which it is installed.

[6] The petitioner claims that newer versions of the ProteKtor™ will have body entrapment protection; staff cannot comment on such technology at this time, but could do so if, and when, the technology is in existence.

[7] Proposed: APSP-*17 Standard for Safety Vacuum Release Systems, Automatic Pump Shut-Off Systems, and Shut-Off Systems*

B. Discussion of Test Reports and Other Attachments Provided with the Petition

The petitioner provides new documentation and test reports in the resubmitted petition. These include the University of Denver Testing report (Attachment 4), the Penn State PSD Flow Adapter report (Attachment 5), the ARL Penn State Test Report (Attachment 6), and the Brazilian National Pool Standard (Attachment 8).

Of the three test reports submitted, the ARL Penn State Test Report directly addresses some of the petitioner's claims. The report includes tests for hair and mechanical entrapments, but it does not include any testing or discussion related to limb entrapment. The University of Denver Testing report and the Penn State PSD Flow Adapter report focus on flow characteristics and design alterations to suction outlet covers, but neither report directly addresses the petitioner's claims related to entrapment protection.

The ARL Penn State Test Report presents testing related to the prevention of hair and mechanical entrapment, with and without a pool drain cover in place; measurements of entrapment forces in hair, and mechanical tests on the ProteKtor™ and on an uncovered suction pipe; and studies of water flow and fit of the ProteKtor™ under the sump cover. As noted, the test report does not address limb entrapment. The ProteKtor™ does not reduce body entrapments, as acknowledged by the petitioner, and the report does not address body entrapment.

The testing presented in the report was not performed using any standard test method, and the test flows used were about half that of typical drain cover flow rating tests. Testing with lower flow rates reduces the likelihood of entrapment. Staff was unable to assess how the ProteKtor™ would perform when subjected to the higher flow rates typically used in drain cover flow rating tests. Additionally, staff determined that adding an obstruction, such as the ProteKtor,™ into the drain sump may actually create a new hair and mechanical entrapment hazard. This new potential entrapment hazard can exist when the drain cover is intact or when it is missing. If the drain cover is present, hair, jewelry, or other objects could still slip through and become entangled with the ProteKtor.™ Based on the information provided, staff was unable to conclude that VDT or the ProteKtor™ could prevent hair or mechanical entrapment.

The petitioner also included a copy of the Brazilian National Pool Standard in the petition. The petitioner claims that the Brazilian standard requires the use of VDT with its use of the term "suction diffuser." Suction diffuser, according to the standard, refers to "a safety device installed in the floor drain or other suction inlet that permits the flow of water and prevents the formation of vortexes and suction vacuum responsible for entrapment." The standard, however, does not *require* the use of a suction diffuser. The standard does require the use of either multiple floor drains, an SVRS, or an atmospheric vent-line connected to the suction intake line. The requirement to use an SVRS or atmospheric vent-line for single main drains is similar to the requirements in the VGBA. Neither standard currently allows the use of a device defined as a "suction diffuser" or "VDT" within the drain sump, as an alternative to other entrapment prevention methods.

IV. Summary of Incident Data Review

Staff discusses in detail the epidemiological data associated with this review in Tab B. Staff characterizes body and limb circulation entrapment incidents associated with public pools, spas, and hot tubs. Staff reviewed incident data dating from 1995 through 2019. Incidents that occurred before the effective date of the VGBA, December 19, 2008, are referred to as "Pre-VGBA," and incidents after this date are referred to as Post-VGBA."

Staff focused on body and limb entrapments for the incident review, because body entrapments are addressed by the five enumerated systems in the VGBA, and limb entrapments may be addressed by VDT and the ProteKtor.™ Staff lists incidents considered in scope and out of scope for this analysis of secondary systems below:

- In Scope – Incidents in public pools and spas involving:
    - Limb entrapments occurring within main drain suction pipes that could have been avoided by blocking pipe access.
    - Body entrapments on pool and spa main drain covers and on exposed sumps that could have been avoided by the installation of a VGBA secondary system.
    - Hair or mechanical entrapments that occurred within a sump suction pipe.
    - Body entrapments involving reversible rectal prolapse.

- Out of Scope:
    - All residential pool and spa installations.
    - Limb entrapments in drain covers, within unblockable drains, in skimmers, and in vacuum and skimmer pipes.
    - Body entrapments within unblockable drains, on skimmers, and on vacuum and skimmer pipes.
    - Hair or mechanical entrapments that occurred in a drain cover.
    - All evisceration incidents, other than rectal prolapse.

To compare the ProteKtor™ as a secondary system, to one of the VGBA secondary systems, in terms of its effectiveness in improving the outcome in each incident, staff determined the scope for the incidents based on the scope of the VGBA and the protection provided by the systems being compared. As such, staff deemed incidents to be out of scope if they involved unblockable drains, skimmers and skimmer piping, and vacuum pipes, because these systems are not subject to the VGBA requirement that single main drains in public pools or spas have secondary systems.

Staff also considered incidents to be out of scope if the particular entrapment described in the incident could not have been prevented by the secondary system. For example, because none of the VGBA secondary systems, or the ProteKtor,™ can protect against hair or mechanical entrapment protection in a drain cover, staff considered incidents involving hair and mechanical entrapment on a drain cover to be out of scope.

Based on the incidents reported to CPSC, staff found a total of 29 incidents, affecting 30 victims, to be within the scope of this analysis. Before the effective date of the VGBA, there were eight

deaths associated with limb and body entrapments. Additionally, one incident resulted in a permanent vegetative state for the victim. Because of the severity of the incident, it was included in the death category for this analysis, which resulted in a total of nine deaths before the effective date of the VGBA. There were also four hospital admissions, four minor injuries, and four incidents of unknown severity reported. After the effective date of the VGBA, only one death was reported for limb and body entrapments. There was one hospitalization, five minor injuries, and one "no injury" incident reported, as well.

Before the effective date of the VGBA, 14 body entrapment incidents and seven limb entrapments were reported. After the effective date of the VGBA, there were seven body entrapment incidents and only one limb entrapment incident reported.

Normalizing these data by year, there were 1.5 incidents and 0.64 deaths per year pre-VGBA. Post-VGBA, there have been 0.73 incidents and 0.09 deaths per year. Since the effective date of the VGBA, based on incidents reported to CPSC, limb and body entrapment incident rates per year have dropped by half, and the death rate associated with these entrapments was reduced by more than 80 percent.

V. Summary of Market and Economic Considerations

The market and economic considerations for the resubmitted petition are described in the memo in Tab C. The overall cost of VDT and the ProteKtor™ could be significantly cheaper than the other five options in the VGBA. This includes initial purchase, installation, and maintenance costs for the device. The ProteKtor™ is currently in use as a fish protection device, and within this market, there are other devices similar to the ProteKtor.™ If VDT/ProteKtor™ were approved as an "other system" within the VGBA, these other devices could also enter the pool and spa market, resulting in competitively driven lower prices in the longer term. In the short term, demand for these devices as an alternative to the more expensive options could temporarily increase the market price.

VDT represents a potentially cheaper alternative to the other five options enumerated in the VGBA. Although the petitioner presented some evidence that the petitioner's specific device, the ProteKtor,™ could protect against limb entrapment, if the drain cover is missing, the petitioner states that VDT/ProteKtor,™ and staff confirms, that it is not effective at preventing full body entrapment. Staff believes that if there was widespread adoption of the petitioner's device, in place of technologies such as SVRS, there could be an increase in incidents involving full body entrapment. This could reverse at least some of the safety gains made since the passage of the VGBA.

VI. Public Comments and Staff Response

CPSC received 17 comments during the public comment period.[8] All comments supported granting the petition. Commenters included industry members, health and safety advocates, first responders, and consumers. This section summarizes the public comments and provides staff's responses to the comments.

Comment Summary 1: *Some comments described experience with drowning incidents and the use of the ProteKtor.™ Several commenters mentioned incidents that they believe would have been prevented by the use of VDT. Another commenter described the use of this device for preventing fish and other objects from entering an intake pipe.*

> Response: Staff understands that VDT may be able to reduce the potential for certain entrapments and that it has been used in other markets to prevent fish and other objects from entering intake pipes. Staff is also aware of incidents that involve entrapment hazards that the petitioner claims can be prevented by the use of VDT or the ProteKtor.™ Staff reviewed incidents associated with pool circulation entrapment hazards as part of this analysis (See Tab A). VDT and the ProteKtor™ may prevent limb entrapments in public pool suction outlets, but they do not prevent body entrapment, which is the most commonly reported incident. The use of VDT and the ProteKtor,™ while useful in an industrial application, may create an additional hair or mechanical entrapment where one did not exist, because the device or technology creates a new obstruction that hair or other objects might become entangled with.

Comment Summary 2: *Commenters provided information on the purpose of the VGBA. Additionally, one comment stated that currently approved systems do not protect against hair, limb, or mechanical entrapments in an open drain. Commenters also stated that the VGBA is preventing new technology from entering the market and that the Act should foster new technology rather than impede its use.*

> Response: Staff acknowledges that the five devices or systems enumerated in the VGBA (safety vacuum release system, suction-limiting vent system, gravity drainage system, automatic pump shut-off system, and drain disablement) may not prevent hair, limb, or mechanical entrapments in an open drain. However, hair and mechanical entrapments do not often occur within the drain sump, where VDT may be effective. Instead, these entrapments are often associated with the drain cover. Staff does not agree that the VGBA is preventing new technology from entering the market or impeding its use. The Act makes clear that VDT could be used in addition to one of the five enumerated systems as an additional level of safety beyond a compliant drain cover. However, VDT cannot be used as an *alternative* to the five enumerated secondary systems unless it is approved as an "other system" under the VGBA. If VDT were to be used, it must be tested for compliance to APSP-16 as part of the suction outlet fitting assembly (SOFA).

[8] https://www.regulations.gov/document?D=CPSC-2019-0024-0001.

Comment Summary 3: *Comments described VDT as a proactive safety device, whereas, the five systems or devices enumerated in the Act are reactive. Comments also provided information related to the demonstration of VDT for the prevention of entrapments. Commenters described demonstrations of VDT that they believe prove its efficacy in preventing hair, limb, or mechanical entrapments. Furthermore, commenters claimed that VDT is inexpensive, easy to install, and does not require maintenance.*

Response: Staff is concerned about the passive nature of VDT, how these types of devices would adapt to different flow conditions, and VDT's failure to protect against body entrapment. Demonstrations of VDT and its ability to prevent hair, limb, and mechanical entrapments may have shown that there is potential for it to be effective in these areas; however, staff is not aware of how these demonstrations were performed and cannot make any assessment of the technology's efficacy without understanding this. VDT could be inexpensive, depending on the product. Installation of the device may be simple, but it could require draining the pool, or the services of a scuba diver. Maintenance would involve inspections to ensure that the device is properly installed and intact. VDT must be removed for winterizing or other pool services. Installation of this device or technology introduces an additional obstruction, where one was not present. This obstruction could introduce the potential for hair or mechanical entrapment. Moreover, the larger issue of body entrapment protection remains unaddressed.

Comment Summary 4: *Writing on behalf of Abbey's Hope Charitable Foundation (Foundation), a commenter expressed support for granting the petition to initiate rulemaking for VDT to be approved as an "other system" within the VGBA. The commenter mentioned the Foundation's experience in helping to draft and pass the Abigail Taylor Pool & Spa Safety Act of Minnesota and also working with Congress to pass the VGBA. The commenter states that the Foundation saw a demonstration of the petitioner's product and how it functioned. The commenter stated: "it is our understanding that the technology is not meant to replace the safety drains or other safety devices required by the [VGBA], but instead is meant to be used as a backup when those safety drain covers or other devices fall off or do not work." The commenter urged the Commission to determine that VDT is equally effective as the other anti-entrapment devices "when used in combination with other safety devices not allowed by the Act."*

Response: The commenter assumes incorrectly that the VDT/ProteKtor™ would simply be used as a backup when the other secondary devices failed to work. If VDT/ProteKtor™ were approved as an "other system," it would be allowed as an alternative to the five enumerated systems in the Act, to stand alone, without any other secondary anti-entrapment system. Staff has no issue with the use of VDT/ProteKtor™ *in addition to* the secondary devices listed in the VGBA. Staff agrees that "no suction or less severe suction" with VDT may reduce the risk of injury, but we believe that the overall goal is to reduce the total risk of injury by first maintaining body entrapment protection.

Comment Summary 5: *One commenter discussed how it is essential that there be redundancy in the safety devices related to entrapment hazards. Compliant drain covers have been effective in increasing safety, but they are not effective when they are not properly installed or not in place, the commenter asserted.*

> Response: CPSC staff agrees that multiple levels of protection are essential under the VGBA. Compliant drain covers are the primary safety device, and the Act requires at least one additional device or system to prevent entrapment by pool or spa drains. The Act does not preclude the use of additional devices or systems beyond this. Therefore, VDT could be used in addition to the devices required by the Act.

Comment Summary 6: *A commenter stated that VDT protects against more types of entrapment than existing technology and that it protects against more prevalent types of entrapments. The commenter also stated that research completed by Penn State University demonstrates that VDT does not create new hazards.*

> Response: The petitioner claims VDT protects against more types of entrapments, *i.e.*, limb, hair, and mechanical entrapments than existing technology. Although staff has found that VDT/ProteKtor™ may offer limb entrapment protection, staff has concerns with the claims about hair and mechanical entrapment protection, as described in the technical review memo found in Tab A. In addition, staff's research of the incident reports and their review of the Penn State University studies indicates that body entrapment is the more prevalent entrapment scenario and that the ProteKtor™ device would not offer the protection that the other five enumerated systems provide against this scenario.

VII. Conclusion

The VGBA directs the CPSC to review new technologies that are developed with the intention of "preventing or eliminating the risk of injury or death associated with pool drainage systems," and if appropriate, determine that they are "equally effective as, or better than" the five methods of entrapment prevention that are enumerated in the law. The petitioner requests that the Commission determine that "vacuum diffusion technology" qualifies as an "other system" under the VGBA.

Staff reviewed the information provided in the resubmitted petition, which included reiterated claims and assertions, letters of support for approval, three technical reports, and the Brazilian Pool Safety Bill. Staff acknowledges, through visual inspection of images of the ProteKtor,™ that this device could reduce limb entrapments when the drain cover is missing. However, staff was unable to conclude, based on the information provided, that VDT or the ProteKtor™ could protect against hair or mechanical entrapment when the drain cover is missing. Moreover, staff is concerned that the ProteKtor™ could introduce new potential for hair or mechanical entrapment. Staff agrees with the petitioner's claim that the ProteKtor™ does not provide body entrapment protection.

The VGBA emphasizes protection against body entrapment, which is more commonly reported, as compared to limb entrapments, in pool circulation-related incidents within the scope of the VGBA. The five enumerated systems in the VGBA, along with the drain cover requirements, provide body entrapment protection. In contrast, VDT and the ProteKtor™ primarily address limb entrapment hazards. After VGBA became effective on December 19, 2008, based on incidents reported to CPSC, the rate of body entrapments dropped by 50 percent, and limb entrapment incidents dropped by more than 80 percent. Between 2009 and 2019, seven body entrapment incidents and one limb entrapment incident within the scope of the Act have been reported. VDT and the ProteKtor™ do not address the entrapment hazard associated with most of the reported incidents. To be considered equally as effective as the five enumerated systems in the VGBA, an "other system" should provide body entrapment protection, at a minimum.

Although staff does not agree with the petitioner's assertion that VDT and the ProteKtor,™ as an example of VDT, are equally as effective as, or better than the enumerated systems in the Act, staff does agree that this technology may provide some level of entrapment protection. VDT may provide some protection, if used in addition to the secondary systems listed in the VGBA. However, staff concludes that VDT and the ProteKtor™ do not meet the criteria provided in the VGBA to be used as an alternative system. The use of VDT in addition to the secondary systems listed in the VGBA is not prohibited by the Act, but VDT would need to be tested for compliance to APSP-16 as part of the suction outlet fitting assembly (SOFA).

VIII. Staff Recommendation

Staff recommends that the Commission deny this petition. Staff determined in its assessment of the information provided in the VGBA 19-1 petition that this technology may protect against limb entrapment when a drain cover is missing, may introduce new modes of hair or mechanical entrapments, and does not protect against body entrapments. Furthermore, staff concluded that VDT, and the ProteKtor,™ as an example of VDT, are not equally effective as the secondary systems enumerated in the VGBA at reducing entrapments in drains and do not meet the requirements to be approved as an "other system" under the VGBA's requirements.

TAB A: Technical Review of 2019 Vacuum Diffusion Technology Petition

TAB A

UNITED STATES
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 8, 2020

TO: Matthew Brookman
Project Manager
Directorate for Laboratory Sciences

Through: Michael A. Nelson
Director, Division of Mechanical Engineering
Directorate for Laboratory Sciences

FROM: Mark Eilbert
Mechanical Engineer, Division of Mechanical Engineering
Directorate for Laboratory Sciences

SUBJECT: Technical Review of 2019 Vacuum Diffusion Technology Petition

Background

In 2019, PSD Industries LLC (PSD, or petitioner), requested[9] that Vacuum Diffusion Technology (VDT) and the ProteKtor,™ as an example of VDT, be listed as an "other system," under the Virginia Graeme Baker Pool and Spa Safety Act (VGBA). More specifically, the petitioner sought permission of the Commission to use VDT/ProteKtor™ to comply with the VGBA requirement that a single blockable drain in a pool or spa water circulating system have a secondary system. An "other system" is defined as: "[a]ny other system determined by the Commission to be equally effective as, or better than, the (secondary systems) at preventing or eliminating the risk of injury or death associated with pool drainage systems.[10]"

This petition is a resubmission of a petition sent to the Commission in 2015.[11] The petition includes a definition of "VDT/ProteKtor, ™" plus renewed claims, assertions, and new test reports. Staff reviewed all the information provided, and staff's technical review assesses

[9] Petition to the Consumer Product Safety Commission to Approve Vacuum Diffusion Technology as an "Other System" under the Virginia Graeme Pool and Spa Safety Act, Paul C. McKain, PSD Industries, LLC, 8/27/2019.
[10] Virginia Graeme Baker Pool and Spa Safety Act, section 1404 (c)(1)(A)(ii).
[11] Petition to Commissioners of the Consumer Product Safety Commission to include "Vacuum Diffusion Technology" into the 'Other Systems' category of the Virginia Graeme Baker Pool and Spa Safety Act, Paul C. McKain/CEO- PSD Industries, LLC, 6/11/2015.

whether the ProteKtor™ can technically be considered an "other system," based on this information.

The petitioner provides technical descriptions, including definitions of "VDT" and the "ProteKtor.™" Staff obtained images of the ProteKtor™ product from the petitioner's website. Test reports submitted by the petitioner purport to describe the functioning of VDT/ProteKtor.™ Assertions or claims by the petitioner address several aspects of VDT/ProteKtor,™ including comparisons to other secondary system technologies.

Definitions and Descriptions

The petitioner presents this definition of "Vacuum Diffusion Technology (VDT)" and asserts "that the ProteKtor™ is an effective example of VDT as an approved "other system":

> *A System that removes the intense vacuum draw from the intake point of a pumping system by occluding the intake orifice in main drains and diffusing the vacuum from a potential blockage immediately and in multiple directions from the blockage. To be considered Vacuum Diffusion Technology, by blocking 50% of the VDT device, the system should not raise the normal vacuum draw by more than .4" Hg. Vacuum Diffusion Technology devices may not be bypassed without the use of a tool for removal as with drain covers, do not require calibration and contain no electronics or moving parts that may malfunction.*

The "ProteKtor™" is defined as:

> *As an exemplar of VDT, the ProteKtor™ is made of PVC plastic – almost the same formulation that the pool piping is made of, is approximately 1/5th the cost of the least expensive SVRS, has no electronics or moving parts to malfunction, does not require calibration, maintenance or monthly testing. It also automatically adjusts to changing conditions in the pool or spa environment. Once installed, it provides perpetual protection against hair entrapment, mechanical entrapment and limb entrapment, the latter of which is in fact the most common entrapment leading to deaths and other serious entrapment injuries.*

The petitioner further claims the ProteKtor™ "diffuses the vacuum from the point of bather contact" and that the "vacuum never increases, and the entrapment is eliminated before it can begin." Additionally, the petitioner claims that the device eliminates "the ability for swimmers to come into contact with the main drain orifice by blocking it." An inspection of the ProteKtor,™ as demonstrated in Figures[12] 1 and 2, indicates that the flow openings are distributed on several different planes. Staff acknowledges that the distribution of holes spreads out the incoming flow and that blocking all of them would be difficult and unlikely. Spa drains and pool drains also have distributed openings. Spa drains, like the ProteKtor,™ are placed on several

[12] http://www.psdindustries.com/product-manual.pdf.

discontinuous planes. Pool drains also spread out the openings, mainly over larger surface areas, to achieve the same purpose of dispersing the incoming flow. Pool and spa drains are also designed to make full blockage difficult to prevent body entrapment. The "ProteKtor™" definition does not claim body entrapment protection.

FIGURE 1. The ProteKtor™ Vacuum Diffuser System

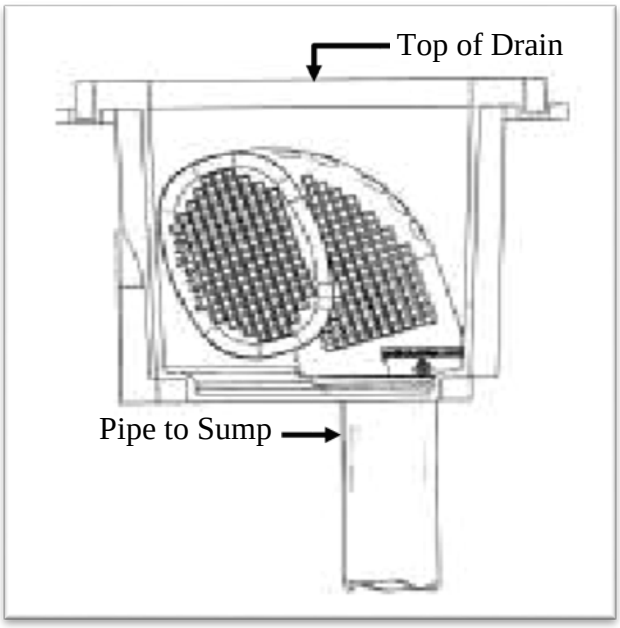


FIGURE 2. The ProteKtor™ Installed in a Drain Sump

The "VDT" definition describes a system in which vacuum pressure is "diffused" or distributed, such that maximum pressures remain within limits when the device is partially blocked. To staff, Figures 1 and 2, and the definitions and other assertions, describe a passive system to block access to the suction pipe, comparable to a drain cover blocking the pipe/sump suction. The

"VDT" definition alludes to hair entrapment, while the ProteKtor,™ as an exemplar of VDT, claims to provide hair, limb, and mechanical entrapment protections. Staff's experience with hair entrapment testing indicates that hair entanglement within the holes in the cover, and not only vacuum pressure, is a major contributor to overall entrapment forces. Similarly, the holes in the cover of the ProteKtor™ may be a potential source of hair entanglement.

Descriptions of the ProteKtor™ convey the same general attributes of a drain cover - PVC material, low cost, no moving parts, no calibration, or maintenance. One difference between the two is the location of the device: a drain cover protects the top of the drain sump (Figure 2), while the ProteKtor™ protects the opening to the sump pipe. Petitioner also describes the ProteKtor™ as offering "perpetual" and "automatic" protection. Staff disagrees with these characterizations. Drain covers are not perpetual – they have service life limits, wear out over time, and need to be replaced. Furthermore, drain covers reduce exposure to entrapment hazards at specific flow conditions--they do not automatically adjust to conditions. This would also be the case with the ProteKtor.™ Additionally, as we will explain, drain covers undergo extensive testing[13] for hair, limb, and body entrapments. Regarding the petitioners claim that the ProteKtor™ offers entrapment protections, staff believes, by inspection, petitioner's assertion that limb entrapment is less likely when the drain cover is missing, and access to the suction pipe opening is blocked. In contrast, however, staff believes that hair and mechanical entrapment would appear *more likely* when access is blocked by partially covering the suction pipe with the perforated ProteKtor,™ which allows hair and mechanical *entanglement*. Hair entanglement, an important cause of entrapments and drownings involving drain covers, could occur in the ProteKtor™ cover holes at a typical water flow rate. Thus, hair entrapment may be more likely to occur with the ProteKtor™ in place, than in its absence. These concerns are discussed in the Test Reports section.

Technical Assessment

ProteKtor™ does not protect against Body Entrapment

The Commission denied the 2015 petition because ProteKtor™ did not have the minimum body entrapment protection required for a secondary system. The petitioner states that approved secondary systems in VGBA do not require body entrapment protections. The petitioner claims that the intent of the "other systems" category is to allow new technologies that can include protections from body, limb, hair, or mechanical entrapment, adding that no one protection is preferred. The petitioner further asserts the "number of entrapments has decreased due to improved drain cover requirements but drain covers still come off or become damaged." The petitioner cites incidents from a 2018 CPSC report[14] that indicate limb entrapments occurred in pipes in open drains. The petitioner asserts that the ProteKtor™ could have prevented those incidents and that the VGBA secondary systems with body entrapment protections could not.

[13] ANSI/APSP-16, Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs.

[14] 2013-2017 Reported Circulation/Suction Entrapment Incidents Associated with Pools, Spas, and Whirlpool Bathtubs, 2018 Report.

Staff disagrees with the petitioner's assessment. An "other system" must be at least the equal of the secondary systems listed in the VGBA. Specifically, the VGBA provides that an "other system" is "[a]ny other system determined by the Commission to be equally effective as, or better than, the systems described in subclauses (I) through (V) of this clause at preventing or eliminating the risk of injury or death associated with pool drainage systems." Subclauses (I) through (V) enumerate specific systems, which are: Safety Vacuum Release System (SVRS), Suction-limiting vent system, Gravity drainage system, Automatic pump shut-off system, Drain disablement, and "Other Systems." Body entrapment can occur on the drain cover, or when removed, at the top of the drain sump.

All the enumerated VGBA secondary systems are designed to provide body entrapment protection, whether the cover is in place or is missing. Virginia Baker, the girl whose name is identified with the VGBA, was entrapped and drowned on an old-style flat drain cover. VGBA requires a compliant drain cover, plus a VGBA secondary system, which provides the level of body entrapment protection for situations where a bather contacts the drain whether the cover is in place or is missing. The ProteKtor™ works when the drain cover is missing. It may provide an important protection from limb entrapment, but it provides no body protection when the drain cover is missing, as the petitioner acknowledges. The VGBA requires that a minimum of one secondary system be installed in public pools or spas with blockable drains. Thus, if approved as a secondary system, the ProteKtor™ could be installed and meet the requirement for one system. The pool or spa would then have the ProteKtor™ but have no secondary device providing body entrapment protection. This would leave the bather with no protection against body entrapment at all. Staff does not believe this was the intent of the VGBA. In reviewing incidents, staff found that body entrapment is the prevalent hazard meant to be addressed by VGBA.

Installation of the ProteKtor™

The petitioner also asserts that the ProteKtor™ cannot be bypassed without the use of a tool. During installation of the ProteKtor,™ a plastic sleeve is first permanently glued into the suction pipe in the sump. The ProteKtor™ is then secured with a tool by a single screw into this sleeve. Similarly, a tool is required to remove the multiple fasteners in drain covers.[15] The requirement of a tool can prevent unauthorized removal, the petitioner asserts.

Staff notes that a removable drain cover is necessary for the periodic maintenance of the pool drain. The ProteKtor™ must also be removable. However, the removal and replacement of screws is known to cause plastic or screw failure over time. For this reason, an endurance test is required for drain cover fasteners.[16] The multiple fasteners in a drain cover provide redundancy in case fasteners/materials begin to fail. As explained, the ProteKtor™ is held in place by only one screw. Staff is concerned that the failure of the single screw can result in the failure of ProteKtor™ to protect against limb, hair, and mechanical entrapments.

The petitioner claims that because the VDT/ProteKtor™ has no electrical components or springs to malfunction, it "does not require resetting in the event of activation and cannot be bypassed."

[15] APSP-16_2017.

[16] APSP-16_2017 section 4.10.

According to the petitioner, "if the VDT is installed under the drain cover it is working." Furthermore, while acknowledging that the ProteKtor™ like a drain cover and can be removed periodically for maintenance, the petitioner asserts: "when the drain cover becomes missing, unlike SVRS's and vent pipes, only VDT will protect the open sump from limb, hair, and mechanical entrapments." The primary layer of protection against pool entrapment is the drain cover. When it is missing, a secondary system provides a backup. There can be differences in failure modes among the VGBA secondary systems, with influences including system complexity. For example, a vent pipe is a passive system with no moving parts, compared to an active, mechanical system like an SVRS. One common characteristic among secondary systems is location-- all VGBA secondary systems are remote from the drain sump. In contrast, the ProteKtor™ is a passive system that is installed at the end of the circulation pipe within the sump. This location of the device can conflict with its function, as we will explain below.

In current VGBA secondary systems, the device is remote from the drain, and body entrapment protection is applied by lowering the pressure holding the entrapment on the drain. By being remote, the secondary systems can't fail or become ineffective due to activities at the drain, such as cleaning or maintenance. If seasonal winterizing requires the suction system to be cleaned, both the drain cover and the ProteKtor™ must be removed to access the suction piping. The petitioner acknowledges this failure does occur with drain covers. The ProteKtor,™ because it can be removed, can fail to protect against the claimed limb, hair, and mechanical entrapments, if the device is removed and not replaced. Staff acknowledges that secondary systems can fail for various reasons, but we also find that, contrary to the petitioner's claim, the ProteKtor™ can be bypassed due to removal, and therefore, it can fail if it is not replaced. The concern also applies to loss of the ProteKtor™ due to screw failure, as we have described.

Unblockable Drains

Petitioner claims the VDT/the ProteKtor™ is demonstrably at least as good as or better than unblockable drains, at a minimum, in addressing the other forms of entrapments that occur when the drain cover is compromised or missing. A pool with an "unblockable drain," by definition, cannot be blocked and is exempt from the requirement of a secondary system. The secondary systems, as well as the ProteKtor™ product, are a choice, but they are not a requirement for pool owners who have pools with unblockable drains. Staff cannot predict the likelihood that a secondary system will be installed if it is left up to choice rather than required. If the limb protection of ProteKtor,™ or the body protection of a secondary system is installed, either device could effectively prevent some entrapment incidents, depending on the specific configuration of the piping below the unblockable drain. In those situations, the voluntary addition of either the VDT or a VGBA secondary system could make an unblockable drain safer. VGBA has no prohibition against the use of the VDT/ProteKtor™ or use of a secondary system for an unblockable drain, although none is required.

Variable Speed Pumps

Petitioner claims that current SVRS devices[17] won't work with variable speed pumps (VSP). Petitioner states that new Department of Energy (DOE) rules for energy efficiency on 1 to 5 hp pool pumps, when effective in 2021, will place performance demands, such that only VSPs will comply. The new DOE rules will establish the first national energy-efficiency standards for dedicated-purpose pool pumps. Pumps sold must exceed a new efficiency metric, termed a "weighted energy factor" (WEF). WEF measures performance in gallons-per-watt-hour energy usage. Many existing single-speed pumps may not comply with the new rules. Petitioner notes that SVRS devices may become more compatible with VSPs through the work of the new APSP-17 National Standard Revision Committee for Safety Vacuum Release Systems, which is expected to address operations of SVRS devices with VSPs. Petitioner claims VDT "functions perfectly with all variable speeds pumps."

An SVRS provides body entrapment protection by releasing water pressure a few seconds after an entrapment occurs. Entrapment causes a lowering pressure spike, which the SVRS device senses and then responds to by releasing pressure. To avoid nuisance triggering, the SVRS is set to trigger on a pressure change that is larger than the typical noisy pressure fluctuation of a normally running pump. If the running pressure changes, for example, due to changing the water flow, most current SVRS devices must be recalibrated manually.

Installing a VSP to manage pool pump operations would present calibration problems for existing SVRS devices if the speed were changed often, but would not present problems if the VSP were used to set a precise speed for a water flow. For example, to set the flow to a certified drain cover rating. Staff concurs that certain SVRS devices would not now work effectively with certain operations of VSPs. However, the choices are not static. Existing SVRS devices can continue to work with existing single speed pumps. As the petitioner notes, the draft APSP-17 SVRS standard may address VSPs by, for example, including testing at varying speeds. SVRS device manufacturers are expected to respond by making improvements or creating new products to comply with the new tests. Pool operators may switch from an older SVRS device to an improved SVRS or to another secondary system that is relatively immune to pressure fluctuations of the VSP, such as a vent pipe.

Like drain covers, VDT and the ProteKtor™ will have higher entrapment forces with higher water flow. Due to standard pump sizing, all pumps are installed as the next higher size available to achieve the desired water flow, with a maximum flow capacity somewhat larger than the desired flow rate. To match the flow rating of the drain cover, the flow from a fixed speed pump supplying a main drain will be throttled down using a valve. Similarly, the speed of a VSP will be adjusted down to achieve the same rated flow. Because of this excess in installed flow capacity, the flow through the drain cover and ProteKtor™ can potentially be increased at any time after installation. Higher water flows result in higher forces than intended. The petitioner does not address this issue by stating VDT "functions perfectly with all variable speeds pumps."

[17] VGBA lists ASME/ANSI A112.19.17 *Manufactured Safety Vacuum Release Systems* and AS™ F2387 Manufactured Safety Vacuum Release Systems (SVRS) for Swimming Pools as standards, at least one of which SVRS devices must conform.

Just like the drain cover installed above it, the maximum flow capacity of a ProteKtor™ device must be considered in each pump installation. And that flow can be increased above a known safe level by pump adjustments, whether using a VSP or a fixed speed pump.

A New ProteKtor™ Version

The petitioner states newer versions of the ProteKtor™ will have body entrapment protection. Staff cannot comment on or assess a product that has not yet been produced, and the definition of VDT provided by the petitioner does not envision body entrapment.

Brazilian National Pool Standard

The petitioner claims that VDT was included in the 2007 Legislative Bill for the new Brazilian National Pool Standard (Bill). The term "suction diffuser," not "vacuum diffuser technology" appears in Art 2: "The term SUCTION DIFFUSER refers to a safety devise installed in the floor drain or other suction inlet that permits the flow of water and prevents the formation of vortexes and suction vacuum responsible for entrapment." It also appears in Art 8: "All safety products and devices described and defined in this law, anti-entrapment drain covers, safety vacuum release system, suction diffuser, and emergency stop button, must be approved by INMETRO[18]." The Bill does require one of several "alternatives to prevent suction accidents": more than one drain, an unblockable drain, an SVRS device, or an atmospheric vent pipe. The Bill does not require the use of a "suction diffuser". But, if used, a suction diffuser as well as any other "safety product" must be approved by the Brazilian regulatory agency INMETRO.

Test Reports

The petitioner provides test reports on hair and mechanical entrapments and water flow parameters. The petitioner does not tie the test report data directly to the assertions that the ProteKtor™ protects against hair, limb, and mechanical entrapments. Staff has reviewed the test reports to determine which findings address the assertions made about entrapment protections.

University of Denver

The University of Denver[19] report studied design considerations in suction outlets and their effect on total kinetic energy of the downstream fluid. The purpose of developing the theoretical fluid flow model was apparently to explore the PSD claims that certain design improvements to commercial suction outlet covers can minimize "fatalities from entrapment by suction." The work explored a "laminarizing funnel" design that affected the total kinetic energy (TKE) of fluid flow entering a pipe. The report concluded that the design "has some merit as we observe a slight drop in the maximum TKE immediately downstream of the funnel."

[18] INMETRO, The National Institute of Metrology, Quality and Technology (INMETRO), a Brazilian regulatory agency.

[19] Petition, Attachment 4 University of Denver Testing, Device Performance Study of a Modified Suction Outlet in Pools and Spas, March 15, 2013.

Penn State PSD Flow Adapter

The Penn State PSD Flow Adapter[20] report addressed tests done at the Applied Research Laboratory on October 2, 2014. The purpose of the tests was to evaluate the fluid flow efficiency of a version of the "adapter/collector and protector." The tests recorded power, flowrate, pump pressures, temperature, and noise level on the "PS adapter in a piping system that is representative of a pool/spa configuration." The executive summary states: "[t]he system configuration with an adapter/collector and protector in a simulated sump increased the flowrate by one gallon per minute (gpm) and resulted in a reduction in the sound level of the pumps." The executive summary adds: "[t]he flow and noise performance of the adapter/collector/protector system could be improved through modeling and additional experimentation." An image shows a "Protector" device attached to a "Collector" and then to piping. The collector appears to be a partial shroud around the protector and is not an evident feature on the current ProteKtor™ device.

ARL Penn State

The objectives of the ARL Penn State report[21] were to demonstrate the prevention of limb, hair, and mechanical entrapment with and without the drain cover, to measure entrapment forces in hair and mechanical tests on the ProteKtor™ and on a bare suction pipe, and to study water flow and fit of the ProteKtor™ under the sump cover. The report describes hair and mechanical tests conducted on the ProteKtor™ and on open pipes. With no drain cover, each entrapment device was lowered into the drain sump using a sideways motion and held in place for 5 to 10 seconds and then released. The entrapment pull forces on hair were reported to be 0 lb with the ProteKtor™ in place, and up to 15 lb on an open pipe, without the ProteKtor™ in place. Pull forces with a "necklace chain" (mechanical) were reported to be 0 lb with the ProteKtor™ in place, and up to 4 lb on an open pipe. The report also details hair and mechanical tests[22] describing contact on the ProteKtor™ and with contact on a drain cover. Those tests reported that the hair and mechanical probes floated free under the 2 lb of probe buoyancy. The water flow was no greater than 55 gpm for all ARL tests. Staff found no tests to demonstrate limb entrapment protection.

Of the three test reports, staff finds that the ARL Penn State report directly addresses some of the claims advanced by the petitioner. There are tests for hair and mechanical entrapments. However, staff found no test or discussion about limb entrapment in the ARL report, or any other report. The University of Denver and Penn State PSD Flow Adapter reports focused on water flow characteristics. While fundamental to researching hair entrapment, as staff understands it, water flow characteristics do not directly address the claim that the ProteKtor™ reduces entrapments, particularly hair entrapments in pool drains.

The ARL Penn State report shows zero force in the pull tests on the ProteKtor™ and less than 2 lb force in the buoyant tests when the hair is pulled from the drain cover. These tests were

[20] Petition, Attachment 5 Penn State PSD Flow Adapter Flow III Final Report, Preliminary Draft PSD Flow Adapter Flow Studies, March 14, 2015.

[21] Petition, Attachment 6, ARL Penn State Test Report-24823 ProteKtor,™ Test Report: ProteKtor™ Test Recording and Documentation, November 14, 2016.

[22] A necklace chain and an elastic band were used in these tests.

conducted with 55 gpm water flow or less. Compare these tests to the hair test procedure in APSP-16,[23] which also measures the pull force on hair on drain covers. The procedure determines the flow rating for drain covers using a 5 lbf pull. Certification to a higher flow rate requires that the 5 lbf pull not be exceeded. So, higher water flows will result in higher hair entrapment forces.

The APSP-16 "ponytail" test with 16-inch-long hair is similar in kind to the ARL hair test. To establish a ponytail hair flow rating, the hair is waved in front of the cover for 30 seconds and then pulled away in a similar, but not equivalent manner as the ARL tests. Hair often enters through the drain cover's holes during these tests, where it can entangle. While the 5 lbf pull is the test criterion, much higher forces result when hair is entangled in the holes. The final flow rating[24] is imprinted on the certified cover, which when installed, must not have more than that water flow. For typical 8-inch pool drain covers, this flow rating often exceeds 100 gpm. At 55 gpm, the ARL test flows with drain covers are about half that of the typical drain cover flow rating. If installed, the ProteKtor™ would be expected to experience the higher flow for which the cover is rated and not the 55 gpm in ARL testing. Testing at 100 gpm would result in higher forces on the hair.

Therefore, staff cannot conclude from the ARL Penn State test reports that the ProteKtor™ does not present a hair entrapment hazard that is less than that of the typical drain cover. Assuming the ProteKtor™ was installed beneath a typical 100 gpm drain cover, it could present a hair entrapment hazard if the hair were to extend through the drain cover and reach the ProteKtor.™ Similarly, the ProteKtor™ adds no potential entrapment hazard if it were rated at the same or a higher flow rating as the cover. In no case does the ProteKtor™ reduce the entrapment potential of a drain cover and ProteKtor™ combination.

Incident Reports

The petitioner submitted entrapment incident data from a 2018 CPSC Incident Report, "2013-2017 Reported Circulation/Suction Entrapment Incidents Associated with Pools, Spas, and Whirlpool Bathtubs," (2018 CPSC Incident Report) in addition to news accounts, to support his position that the ProteKtor,™ as a secondary system, could effectively prevent entrapments. The CPSC report covered 5 years of data from 2013 to 2017, and the three news reports covered incidents from 2018 to 2019. For this analysis, staff reviewed CPSC data over a broader range from 1995 to 2019, and estimated the relative effectiveness in entrapment prevention for the ProteKtor (limb) and for VGBA secondary systems (body). Staff also estimated from the data, the overall contribution of the VGBA, effective in 2009, on the decrease in limb and body entrapments across those years.

[23] ANSI/APSP-16, *Suction Fittings for Use in Swimming Pools, Wading Pools, Spas, and Hot Tubs*

[24] In the APSP-16 test method, the final flow rating marked on the drain cover is the lesser flow rating among two hair tests and one body blockage test.

2018 CPSC Incident Report

CPSC publishes an annual update of circulation/suction entrapment incidents in pools and spas. The petitioner cites the 2018 CPSC Incident Report, and claims that of the 11 incidents, the ProteKtor™ likely would have prevented at least nine (82%) of these entrapments. The entrapments referred to are the six hair entrapment and three limb entrapment incidents. The other two incidents were body entrapments on skimmers, which are exempt from the VGBA requirement for secondary systems. Upon review, staff finds that all six hair entrapments occurred with drain covers. The ProteKtor™ would not have positively affected the outcome of those incidents because the drain cover is separate and upstream from the ProteKtor,™ which is positioned at the bottom of the pool drain sump. Three incidents involved limb entrapment, two resulting in drowning. All three incidents occurred in residential pools in which the drain cover was missing.

Staff agrees that the ProteKtor™ would have been effective in preventing the hand, foot, and arm entrapments in those incidents. However, because all three of the pools were residential, and not public, the owners would not have been required to install a VGBA secondary system or the ProteKtor,™ if approved as one. Nevertheless, staff can determine that the ProteKtor,™ if installed voluntarily, could have been effective at preventing 27 percent (3 of 11) of the incidents in the 2018 report, instead of the 82 percent claimed by the petitioner.

Published News Reports

The petitioner also cites more recent incidents: a limb entrapment in a water park in South Carolina in 2018; a hair entrapment within an open pipe in Pennsylvania in 2019; and a body entrapment in a water park in Texas in 2019. The news report in the Pennsylvania[25] incident indicates an 8-year-old girl was rescued from a wading pool after "her hair was sucked into the drain of the filtration system." From this description, it's likely that her hair was entangled in the drain cover. Hair entrapment in a drain cover could not have been addressed by the installation of the ProteKtor.™

In the Texas[26] incident, a 14-year-old boy at a water park "slipped after lifting a drain grate, causing him to get sucked in." Staff notes that neither an existing secondary system, nor the ProteKtor,™ would be required by VGBA, because waterpark grates, although size was not reported, are typically of an unblockable size, and therefore, are exempt from VGBA requirements for secondary systems.

In the South Carolina incident, a secondary system would not have been required because the drain was not blockable. The incident occurred below a 3-foot x 3-foot grate, which is larger than the 18-inch x 23-inch size of an unblockable drain, and as such, does not require a secondary system. Although the petitioner asserts that the ProteKtor™ could have prevented the entrapments beneath unblockable drains, there is no legal requirement to install any VGBA secondary system with an unblockable drain. Staff notes that currently, there is nothing

[25] Erie News, July 2019.
[26] Daily News (Crystal Beach, TX), August 2019

prohibiting pool operators of pools with unblockable drains from installing the ProteKtor,™ if they wish to do so.

1995-2019 CPSC Incidents

The petitioner claims that the ProteKtor™ is "'as good or better' than any full body only anti-entrapment methods currently recognized by the CPSC under the VGBA." In addition, the petitioner asserts that "only VDT will protect the open sump from limb, hair, and mechanical entrapments in their entrapment statistics release." These claims address the ProteKtor's™ effectiveness at entrapment prevention, as compared to all of the VGBA secondary systems. To assess this, staff independently reviewed incident reports that covered a wide time period, both before and after the VGBA became effective, to determine which entrapment prevention system could possibly have prevented the entrapment. Incident data are reported[27] in the Epidemiology Memorandum. Incident reports were filtered to include those involving main drains in public pools, which were within the scope of the VGBA's secondary system requirements, and that involved entrapment hazards that either the ProteKtor,™ or VGBA secondary systems, could possibly have prevented. No residential pool/spa incidents were included, because only public pools are subject to the VGBA secondary system requirements.

Incidents outside the scope of the VGBA secondary system requirements involve unblockable drains, bathtubs with circulating systems, and pool auxiliary systems, such as skimmer-related and vacuum-cleaning fixtures. All hair and mechanical incidents were excluded, because each involved entrapment in a drain cover, which cannot be ameliorated by the presence of the ProteKtor,™ or any VGBA secondary system.

Staff excluded evisceration because staff is not aware of any VGBA secondary system that can react to preempt this fast-acting body entrapment hazard. Limb entrapments occurring within main drain suction pipes that could have been avoided by blocking pipe access were included. Limb entrapments in drain covers, within unblockable drains, and in vacuum and skimmer pipes were excluded. Body entrapments on pool and spa main drain covers, and on exposed sumps that could have been avoided by the installation of a VGBA secondary system, were included. Body entrapments within unblockable drains, on skimmers, and on vacuum and skimmer pipes, were excluded.

From the 1995 to 2019 incident data, incidents for body and limb entrapments during periods before and after the effective date of VGBA, are tabulated (Figure 5 in the Epidemiology Memorandum) in Table 1 below. The incidents were filtered as previously described for the effects that the ProteKtor™ and VGBA secondary systems could have had at reducing limb and body entrapment incidents. The numbers, therefore, represent incidents that staff considers addressable (*i.e.*, avoidable) by the ProteKtor™ (limb), or a VGBA secondary system (body).

[27] 1995–2019, Reported Circulation/Suction Entrapment Incidents Associated with Pools and Spas Subject to the Virginia Graeme Baker Pool and Spa Safety Act, Matthew V. Hnatov, Division of Epidemiology, March 2020.

Table 1
Reported Circulation Entrapments Associated with Pools and Spas
By Entrapment Type, 1995–2019

Entrapment Type	Pre-VGBA	Post-VGBA	Total
Body	14	7	21
Limb	7	1	8
Total	**21**	**8**	**29**

Source: Epidemiology Memorandum

Table 1 covers 25 years for incidents pre-VGBA from 1995 through 2008 (14 years) and incidents after VGBA from 2009 through 2019 (11 years). To compare pre-VGBA and post-VGBA, the incidents in those periods are divided by the number of years in each period. Incident rates are presented on a per-year basis of the incidents known to CPSC. These rates and percent changes are not indicative of usage patterns and are just presented to demonstrate changes between yearly totals. These incidents per year, over the two VGBA periods, are shown in Table 2.

Table 2
Reported Circulation Entrapments Associated with Pools and Spas
By Entrapment Type, 1995–2019
Average Incidents per Year

Entrapment Type	Pre-VGBA	Post-VGBA
Body	1.0	0.64
Limb	0.50	0.09
Total	**1.5**	**0.73**

Source: Table 1. Pre-VGBA divided by 14 years; post-VGBA divided by 11 years.

From Table 2, body entrapments dropped from 1.0 pre-VGBA to 0.64 post-VGBA average incidents per year, a 36 percent decrease. Limb entrapments dropped from 0.50 pre-VGBA to 0.09 post-VGBA average incidents per year, an 82 percent decrease. With this dataset, it's likely that the VGBA is the cause of the positive effect on limb and body drain entrapments: From Table 1, incidents of body entrapment dropped from 14 to seven, while incidents of limb entrapment dropped from eight to one. Staff knows of no plausible intervening reason limb entrapments should drop, and posits that the likely reason for this drop is improved drain covers stay in place. Body entrapments could have dropped due to the presence of post-VGBA secondary systems, in addition to the improved drain covers, but this cannot be determined from the data.

Tables 1 and 2 do not support the petitioner's claim that the ProteKtor™ is superior to VGBA secondary systems. If the ProteKtor™ is approved as a secondary system, a pool owner may choose the ProteKtor™ or another VGBA secondary system. Although more than one secondary

system may be installed, this is not legally required. The choice to install the ProteKtor™ is a choice that supports limb entrapment protection, but not body entrapment protection. From Table 1, the one post VGBA limb entrapment could have been avoided if the ProteKtor™ had been installed in that incident pool. However, none of the seven post-VGBA body entrapments could have been avoided with the ProteKtor.™ Many of the post-VGBA body entrapments could have been avoided with a properly working VGBA secondary system. Thus, staff concludes that the ProteKtor™ would not have protected against as many incidents as a properly working VGBA secondary system: one limb entrapment versus seven body entrapments, respectively.

Summary of Staff's Technical Assessment

Staff was able to assess whether, if approved as an "other system," the ProteKtor™ could provide the limb, hair, and mechanical protections claimed in the petition.

The petitioner does not present any structural tests or evidence to support the claim that the ProteKtor™ provides limb entrapment protection. None of the test reports address limb entrapment. Nonetheless, through a visual inspection of the ProteKtor,™ staff agrees that the ProteKtor™ can provide some level of protection against limb entrapment. The ProteKtor™ physically blocks access for limbs to enter the sump pipe, and the holes in the ProteKtor™ appear to be sized to prevent finger entrapment. Finger entrapment is a special concern because it exists with, but not without, the ProteKtor™ present. Although staff believes that the ProteKtor™ may offer protection from limb entrapment, staff is concerned that the ProteKtor™ may be vulnerable to physical damage from its exposed location within the sump. Reasonable physical tests for product failure, such as those in APSP-16, can assess whether the ProteKtor™ and its entrapment protections can survive expected abuse.

The petitioner claims that the ProteKtor™ protects against hair and mechanical entrapment and provides test data to support the claim. The ARL Penn State tests highlight the difference between the relatively high forces present when the hair device is placed near an open pipe or is inserted into an open pipe (not clear which), and the forces present when the test hair is touching the ProteKtor.™ Those tests contrast whole hair device entrapments in open pipes with those entanglements with the ProteKtor.™. The entrapment forces at the pipe opening could have resulted from the test device plugging the pipe, such as a stick covered by hair, rather than simply hair entrapment. Which of these situations predominated in the tests is not clear. Entrapments involving the full head against open pipes, although rare, have occurred. However, these incidents are considered body part entrapments and do not directly involve hair. Most importantly, staff's review of the incident reports covering the period of 1995 to 2019 do not show any hair or mechanical entrapments in an open pipe. Rather, staff found that all hair and mechanical entrapments occurred with drain covers or other obstructions. Staff questions whether the ARL Penn State hair entrapment test method involving open pipes and the ProteKtor,™ relates to any real-life entrapment hazard with the drain cover removed.

ARL Penn State obtained the near-zero hair forces when the hair was brought into contact with the ProteKtor™ using a test method they had devised. This non-standard test also used half the flow rate of a typical small pool drain. Drain covers are tested per ANSI/APSP-16 up to the maximum flow allowed by a 5 lb removal force and under a standard test method. Because the

ProteKtor™ is physically and functionally similar to a drain cover, staff believes that a reasonable assessment of hair entrapment should follow the APSP-16 hair test method, or a similar test method. As such, staff does not find the petitioner's claims that the ProteKtor™ provides hair and mechanical entrapment protections to be fully substantiated through these ARL Penn State tests.

Staff disagrees with claims that the ProteKtor™ is as good as or better than the VGBA secondary systems. Although the ProteKtor™ is protected inside the drain sump, it is vulnerable, like a drain cover, to loss of its one attachment screw, and wear due to seasonal maintenance. Secondary systems each have their own calibration and maintenance issues, but none of the enumerated secondary systems in the VGBA are vulnerable at the sump. As the petitioner points out, current SVRS devices are vulnerable to changing water flow rates, which could become more prevalent with widespread use of variable speed pumps. That will be a challenge for SVRS voluntary standards groups and manufacturers. However, as discussed, staff finds that changing water flow rates will also affect the ProteKtor.™ Because the device has no provision for adjustments, it is vulnerable to increased entrapment forces with increased water flow. This was not addressed in the petition.

The incident reports on limb and body entrapments provided in the Epidemiological memorandum indicate to staff that the VGBA has been effective in reducing circulation entrapments in public pools. There was only one limb entrapment in the post-VGBA period (2009 to 2019), representing an 82 percent reduction from the pre-VGBA period (1995 to 2018), on an average yearly basis. This result strongly indicates that newly installed drain covers have prevented limb entrapments. Body entrapments were reduced by 36 percent on an average yearly basis. What portion of this result is due to improved drain covers, or secondary systems, is not known; although the parallel effect on limb entrapments does suggest the overall important role of drain covers. The success of drain covers appears to be a critical factor in entrapment reductions in reductions in both limb and body entrapments.

Staff disputes the petitioner's claim that the 2018 CPSC incident report shows that the ProteKtor™ could have addressed 82 percent of the 11 entrapment incidents. Rather, staff finds that only the three limb entrapments could have been avoided. Because all three of the entrapment incidents occurred in residential pools, none of the three would have been avoided by using the Protektor because the VGBA requirements pertain to public pools only.

If the Commission approved the ProteKtor™ as a secondary system, it would provide new limb entrapment protections. However, using the ProteKtor™ where required would remove body entrapment protections, which staff finds to be the prevalent hazard scenario of these two types of entrapments. The result of this tradeoff would be more body entrapments as suggested by the greater numbers of body versus limb entrapments in the incident data.

From Table 1, the one post-VGBA limb entrapment could have been avoided if the ProteKtor™ had been installed in that incident pool. However, none of the seven post-VGBA body entrapments could have been avoided with the ProteKtor,™ although many could have been avoided with a properly working VGBA secondary system. Staff concludes that improved compliance with the VGBA could result in further reductions in body entrapments. Allowing the

ProteKtor™ to become a VGBA secondary system may reduce the already low incidence of limb entrapments, but that may come at the cost of increasing the number of body entrapments.

In summary, staff has concerns that the ProteKtor™ will not provide the necessary entrapment protections if it were to become a VGBA secondary system. The ProteKtor™ can possibly provide only limb entrapment protection. Staff was not convinced of the claimed hair and mechanical entrapment protections. The ProteKtor™ is as vulnerable to loss as a drain cover. Both the ProteKtor™ and drain covers must be removed for normal seasonal maintenance of the pool drain. Incident reports indicate that improved compliance with the VGBA's requirements for drain covers and secondary systems is more likely to result in further reductions in entrapment incidents than allowing the ProteKtor™ to become a secondary system. Most importantly, the ProteKtor™ does not provide the body entrapment protection that all the VGBA enumerated systems provide. If approved by the Commission as a secondary system, the ProteKtor,™ with limb protection only, would be allowed to replace VGBA secondary systems that offer body protection. This would leave installed pool drains without any secondary body entrapment protection.

TAB B: 1995-2019 Reported Circulation/Suction Body and Limb Entrapment Incidents Associated with Pools and Spas Subject to the Virginia Graeme Baker Pool and Spa Safety Act

TAB B

United States
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 7, 2020

TO: Matthew Brookman
Project Manager
Directorate for Laboratory Sciences

Through: Risana Chowdhury
Director, Division of Hazard Analysis
Directorate for Epidemiology

FROM: Matthew V. Hnatov
Mathematical Statistician, Division of Hazard Analysis
Directorate for Epidemiology

SUBJECT: 1995–2019 Reported Circulation/Suction Body and Limb Entrapment Incidents Associated with Pools and Spas Subject to the Virginia Graeme Baker Pool and Spa Safety Act

Introduction

This memorandum characterizes the information on circulation entrapment incidents associated with public pools and spas,[28] specifically, body and limb entrapments reported to U.S. Consumer Product Safety Commission (CPSC) staff. A "circulation entrapment" is defined as an entrapment involving the water circulation system of a product. A multidisciplinary team of CPSC staff developed this definition and determined the types of products that are of interest regarding circulation entrapments. The purpose of this report is to provide engineering staff incident data to analyze the effects that the VGBA has had on limb or body entrapments. This memorandum covers the years 1995 through 2019. In this analysis, the incidents that occurred before December 19, 2008, are referred to as "pre-VGBA," and incidents that occurred from December 19, 2008 through 2019, are referred to as "post-VGBA." Data are included for main

[28] The term "spa" is used to refer to spas and hot tubs.

*This analysis was prepared by CPSC staff. It has not been reviewed or approved by, and may not necessarily reflect the views of, the Commission. CPSC Hotline: 1-800-638-CPSC (2772) CPSC's Web Site: http://www.cpsc.gov.

drain circulation systems in public pools and spas that experienced limb and body entrapments. Bathtubs with circulating systems, pool auxiliary systems, such as skimmer-related and vacuum cleaning fixtures, are out of scope because they are not part of a direct main drain system and are not subject to the VGBA. In addition, the VGBA does not apply to privately owned and used pools. The team also excluded hair and mechanical entrapments that occur exclusively in drain covers or broken drain covers and cannot be addressed with any known or proposed secondary system. Eviscerations are excluded because no known secondary system can react fast enough to avoid that hazard. For more information, refer to the Engineering Memorandum.

Incident Data

From 1995 through 2019, CPSC staff received reports of 29 incidents involving 30 victims of circulation entrapments as identified by the team. Incidents are counted for both pre-VGBA and post-VGBA periods, if limb entrapment or body entrapment could have possibly been avoided by the appropriate installation of a device that either blocks limb access or that complies with the VGBA requirement for secondary systems, respectively. The types of entrapment that were deemed in scope or out of scope for this memo are listed below:

- In Scope – Incidents in public pools and spas involving:
    - Limb entrapments occurring within main drain suction pipes that could have been avoided by blocking pipe access.
    - Body entrapments on pool and spa main drain covers and on exposed sumps that could have been avoided by the installation of a VGBA secondary system.
    - Hair or mechanical entrapments that occurred within a sump suction pipe.
    - Body entrapments involving reversible rectal prolapse.

- Out of Scope:
    - All residential pool and spa installations.
    - Limb entrapments in drain covers, within unblockable drains, in skimmers, and in vacuum and skimmer pipes.
    - Body entrapments within unblockable drains, on skimmers, and on vacuum and skimmer pipes.
    - Hair or mechanical entrapments that occurred in a drain cover.
      All evisceration incidents, other than rectal prolapse.

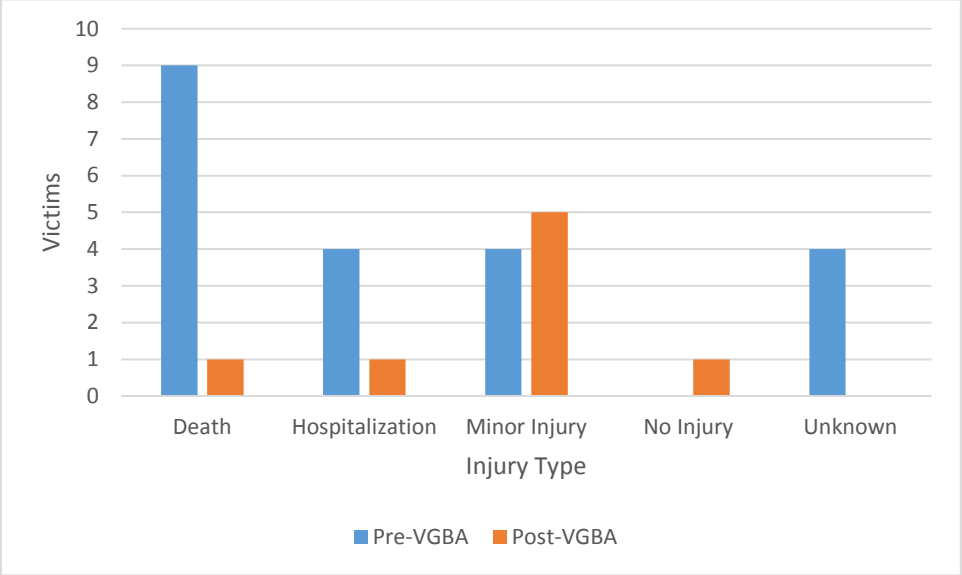
There were no hair, mechanical, or evisceration incidents that fit the screening criteria. For that reason, these hazard categories were not included in the analysis. Appendix A provides the methodology used for extracting the data, and Appendix B provides the summary of the 29 reports including 30 victims. Table 1 and Figure 1 below provide a summary of the reported incidents.

Table 1
Summary of Reported VGBA Applicable Incidents, 1995-2019

Injury Severity	Pre-VGBA	Post-VGBA	Total
Death	8	1	9
Permanent vegetative state	1		1
Hospital Admission	4	1	5
Hospital Treated and Released	4	2	6
Doctor visit		2	2
First aid administered		1*	1*
No Injury		1	1
Unspecified	4		4
Total	**21**	**8**	**29**

Source: CPSC database Consumer Product Safety Risk Management System (CPSRMS).
Reporting is ongoing for 2017–2019.
*This incident involved two individuals.

Figure 1
Number of Victims of Reported Circulation Entrapments by Injury Severity 1995–2019



Source: CPSC database: Consumer Product Safety Risk Management System (CPSRMS).
Reporting is ongoing for 2017–2019.
The category labelled "Death" also includes the case where the victim was diagnosed has being in a permanent vegetative state.

Because of the severity and the non-recoverable nature of the injury, the victim diagnosed as being in a permanent vegetative state will be included in the "Death" category.
Of the 21 incidents associated with pre-VGBA pools and spas, 13 involved pools (7 deaths) and 8 involved spas (2 deaths). Of the 8 incidents involving Post-VGBA pools and spas, 6 involved pools (1 death), and 2 involved spas (no deaths).

Table 2 summarizes the circulation entrapments broken down by gender. There does not appear to be a difference by victim's gender for both the pre-VGBA incidents and the post-VGBA incidents.

Table 2
Number of Victims of Reported Circulation Entrapments by Victim Gender
1995–2019

Gender	Pre-VGBA	Post-VGBA*	Total
Female	10	4	14
Male	11	5	16
Total	**21**	**9**	**30**

Source: CPSRMS. Reporting is ongoing for 2017–2019.
Includes the incident where 2 victims required first-aid treatment–one female and one male.

Table 3 shows the distribution of reported victims by age category and VGBA status. All but four of the victims were children below the age of 15; and since VGBA was enacted, there has been only one victim age 15 or older.

Table 3
Number of Victims of Reported Circulation Entrapments by Victim Age
1995–2019

Age	Pre-VGBA	Post-VGBA	Total
Under 5	1	4	5
5 to 9	7	1	8
10 to 14	10	3	13
15 or older	3	1	4
Total	**21**	**9**	**30**

Source: CPSRMS. Reporting is ongoing for 2017–2019.

Using definitions developed by the Association of Pool and Spa Professionals (APSP), there are five types of circulation entrapment: (1) body, (2) limb, (3) evisceration/disembowelment, (4) hair, and (5) mechanical.[29] "Limb entrapment" happens when a limb is sucked or inserted into an open sump or pipe. If only a limb was involved in the entrapment, then the incident was coded as "limb entrapment" (*i.e.*, arms, hands, legs, or feet). "Evisceration/disembowelment" concerns suction applied directly to the intestines, such as when a child sits on an open sump. "Hair entrapment" occurs when hair becomes caught in an outlet cover. Incidents involving hair were coded as "hair entrapments." "Mechanical entrapment" involves articles of clothing, jewelry, or appendages caught in an outlet cover. "Appendages" refers to digits (*i.e.*, fingers or toes). Incidents involving appendages only, were coded as "mechanical entrapments." Finally, "body entrapment" occurs when suction is applied to a large portion of the body or limbs. For

[29] ANSI/APSP-7 2006, *American National Standard for Suction Entrapment Avoidance in Swimming Pools, Wading Pools, Spas, Hot Tubs, and Catch Basins*, p. viii.

this analysis, incidents were coded as a "body entrapment" if the entrapment involved a portion of the body not covered by the other types of entrapment. Examples of body entrapment include suction to such areas as: the shoulder and upper arm, abdomen, back, or hip. Hair and mechanical entrapments are out of scope for this analysis because incident review has shown that these hazards are always associated with drain covers and cannot be ameliorated by the selection of a secondary system. Evisceration is excluded because CPSC staff is not aware of a secondary system that could avoid that fast-acting hazard.

Based on the reported incidents that meet the criteria of this memo, CPSC staff identified body entrapment (22 victims, 73 percent of victims) as the most frequently occurring entrapment hazard compared to limb entrapments. In the post-VGBA era, only one of the nine reported incidents was classified as a limb entrapment. Table 4 displays the data for circulation entrapment of victims by entrapment type and VGBA status.

Table 4
Reported Circulation Entrapment Incidents Associated with Pools and Spas by Entrapment Type, 1995–2019

Entrapment Type	Pre-VGBA	Post-VGBA	Total
Body	14	7	21
Limb	7	1	8
Total	**21**	**8**	**29**

Source: CPSRMS. Reporting is ongoing for 2017–2019.

Appendix A – Methodology for Extracting Reported Circulation Entrapments Associated with Pools, Spas, and Whirlpool Bathtubs

This report covers the period from 1995 through 2019. Data were extracted on February 2, 2020, from the Consumer Product Safety Risk Management System (CPSRMS) for the product codes enumerated in Table A.

Table A–Product Codes Used in Extracting Circulation Entrapment Data

Product Code	Description
3251	Built-in swimming pools
3262	Swimming pool equipment
1284	Swimming pools, not specified
698	Hot tubs or home spas

Within these product codes, suction/entrapment incidents were identified using the following keyword search terms: "SUCTION," "SUCK," "STUCK," "TRAP," "CAUGHT," "HELD," "TANGLE," "UNDER," "WEDGE," "JAMM," "DRAIN," "PUMP," "FILTER," "PIPE," "INTAKE," "GRATE," "COVER."

Staff reviewed reports to eliminate cases that did not involve circulation entrapments in public pools and spas. Note: data collection is ongoing for CPSRMS. CPSRMS combines death certificates (DTHS), In-Depth Investigations (INDP), and Injury and Potential Injury Incidents (IPII) from newspaper clippings, consumer complaints, state/local government referrals, and medical examiners/coroners. In addition, staff generally continues to receive reports for the most recent years. Information from these cases was extracted into an Excel spreadsheet and sorted by incident state and date. Staff checked source documents to eliminate duplicate incident reports. Once the incident set was established, staff examined the incident reports to code the additional characteristics of circulation entrapment type and hazard scenario.

Appendix B - Summary Suction Entrapment Incidents for Pools and Spas Subject to VGBA, 1995–2019

VGBA	Incident Report Number	Year	Type	Injury	Age	Gender	Scenario	Incident Narrative
Pre-VGBA	F9615008C	1995	Spa	Death	9	Female	Body	A 9YOF DROWNED IN A SPA WHEN HER CHEST WAS SUCKED TO THE BOTTOM.
Pre-VGBA	X9662818A	1996	Pool	Hospital Admission	67	Female	Body	VICTIM, A 67 YEAR OLD FEMALE, WAS SUCKED UNDER WATER AGAINST A POOL DRAIN, WHICH DID NOT HAVE A GRATE OVER IT, WHILE SHE WAS IN THE POOL TAKING SWIMMING LESSONS. VICTIM WAS PULLED UNCONSCIOUS FROM THE POOL, BUT WAS RESUSCITATED A SHORT TIME LATER.
Pre-VGBA	N9650238A	1996	Spa	Death	16	Female	Body	A 16 YEAR OLD FEMALE DROWNED IN THE HOT TUB OF AN ATHLETIC CLUB WHEN SHE APPARENTLY FELL ON TOP OF A 12 INCH SQUARE HYDROTHERAPY FLOOR DRAIN WITH HER BUTTOCKS COMPLETELY COVERING THE DRAIN GRATE. THIS FORMED A COMPLETE VACUUM HOLDING THE VICTIM UNDER THE 3' OF WATER IN THE HOT TUB. THE VICTIM WAS AT THE ATHLETIC CLUB AS PART OF THE PLANNED FESTIVITIES TO KEEP STUDENTS FROM DRINKING AND DRIVING FOLLOWING THEIR HIGH SCHOOL JUNIOR PROM THE EVENING BEFORE.
Pre-VGBA	H96B0098A	1996	Spa	Unspecified	4	Female	Body	A GIRL, AGE 4, WAS BRUISED USING AN ELECTRIC HOT TUB AT A MOTEL WHEN SHE LEANED AGAINST THE CIRCULATION OUTLET AND WAS SUCTIONED AGAINST IT.
Pre-VGBA	X9962152B	1997	Spa	Unspecified	6	Male	Body	A BOY, AGE 6, RECEIVED A STOMACH INJURY WHEN HIS STOMACH WAS SUCKED INTO A SPA DRAIN.
Pre-VGBA	N9780133A	1997	Pool	Unspecified	6	Female	Limb	A GIRL, AGE 6, SUFFERED BRUISING AND SWELLING TO HER ARM AFTER IT BECAME CAUGHT IN THE WASTE DRAIN OF THE SWIMMING POOL AT A CONDOMINIUM CLUB. THE COVER TO THE VALVE WAS NOT REPLACED FOLLOWING A VACUUMING EARLIER IN THE DAY.
Pre-VGBA	F97B5006A	1997	Pool	Death	12	Male	Limb	A 12 YEAR OLD BOY DROWNED WHEN HE SUFFERED BODY ENTRAPMENT WHILE SWIMMING IN A PUBLIC POOL. HE WAS RETRIEVING A RING THAT HAD FALLEN INTO THE DRAIN WHEN HIS ENTIRE LEFT ARM WAS DRAWN INTO AN UNCOVERED 12 INCH DRAIN BY THE SUCTION FORCE OF THE PUMP MOTOR. HE COULD BE PULLED FREE OF THE DRAIN ONLY AFTER THE PUMP MOTOR WAS TURNED OFF.
Pre-VGBA	9829103761	1998	Pool	Death	11	Female	Limb	AN 11 YEAR OLD GIRL DIED AFTER SHE NEARLY DROWNED IN THE SWIMMING POOL AT A CHURCH. THE VICTIM AND A FRIEND REMOVED THE GRATE ON THE SWIMMING POOL DRAIN WHILE TRYING TO RETRIEVE A COIN THAT HAD FALLEN THROUGH AND HER LEG BECAME CAUGHT. HER LEG BECAME STUCK AND SHE WAS SUBMERGED, UNDER THE POOL WATER, ABOUT 25 MINUTES BEFORE SHE COULD BE FREED. SHE LATER DIED IN A HOSPITAL.
Pre-VGBA	990317HEP9002	1999	Spa	Hospital Treated and Released	12	Male	Body	THE 12 YEAR OLD MALE VICTIM WAS STAYING WITH HIS FAMILY AT A SKI RESORT WHEN HE WAS INJURED. THE VICTIM AND HIS BROTHERS GOT INTO A HOT TUB AND THE VICTIM SAT AGAINST THE FILTER. THE SUCTION OF THE FILTER CAUSED A CONTUSION TO THE VICTIM'S BACK WHICH WAS VERY SEVERE. THE VICTIM WAS TAKEN TO THE HOSPITAL WHERE HE WAS EXAMINED, TREATED, AND RELEASED.
Pre-VGBA	990729CEP9032	1999	Spa	Hospital Treated and Released	9	Male	Body	A NINE-YEAR-OLD MALE RECEIVED A CONTUSION TO HIS ABDOMEN WHILE PLAYING IN A PARTIALLY FILLED HOT TUB AT A MOTEL. THE VICTIM WAS LAYING PRONE ON THE FLOOR OF THE HOT TUB COVERING THE DRAIN WITH HIS STOMACH. THE DRAIN'S SUCTION PULLED HIM DOWN AND HE WAS NOT ABLE TO FREE HIMSELF. ANOTHER CHILD PULLED HIM OFF.

VGBA	Incident Report Number	Year	Type	Injury	Age	Gender	Scenario	Incident Narrative
Pre-VGBA	N0050277A	2000	Pool	Death	8	Male	Body	A BOY, AGE 8, DROWNED AFTER SNEAKING INTO A FENCED-IN MIDDLE SCHOOL SWIMMING POOL AND GETTING SUCKED TO THE BOTTOM AGAINST A CIRCULATION DRAIN. HE WENT IN TO THE POOL TO RETRIEVE A TENNIS BALL.
Pre-VGBA	N0080209B	2000	Pool	Permanent vegetative state	14	Male	Limb	A 14-YEAR OLD MALE WAS SWIMMING IN AN IN-GROUND SWIMMING POOL AT HIS MOTHER'S APAR™ENT WHEN HE SOMEHOW GOT HIS LEFT HAND ENTRAPPED IN THE POOL DRAIN AT THE BOTTOM OF THE POOL. AFTER AN ESTIMATED 7-9 MINUTES OR MORE SUBMERSION, THE VICTIM WAS EXTRICATED AND TRANSPORTED AND ADMITTED TO A NON- NEISS HOSPITAL. PROGNOSIS FOR VICTIM IS THAT HE WILL REMAIN IN A PERSISTENT VEGETATIVE STATE.
Pre-VGBA	X0990021A	2000	Pool	Hospital Treated and Released	7	Male	Limb	7 YEAR OLD BOY LEFT HAND BECAME CAUGHT IN A DRAIN AT THE BOTTOM OF A HOTEL SWIMMING POOL WHEN HE TRIED TO RECOVER AN ASHTRAY FROM THE DEEP END OF THE POOL. HE WAS TRANSPORTED TO THE HOSPITAL WHERE HE WAS TREATED & RELEASED.
Pre-VGBA	X00B5166A	2000	Pool	Death	12	Male	Body	A MALE, AGE 12, WAS SWIMMING IN A IN-THE-GROUND POOL AT A HOTEL WHEN HIS HEAD GOT CAUGHT IN A DRAINAGE SUCTION PIPE IN THE POOL. CAUSE OF DEATH ACUTE CEREBRAL EDEMA, SUBDURAL AND SUBARACHNOID HEMORRAHAGE, RIGHT SIDE HEMOTHORAX.
Pre-VGBA	X0990020A	2000	Pool	Hospital Admission	11	Female	Limb	11 YEAR OLD GIRL WAS HOSPITALIZED FOR DAYS AFTER DOING A HANDSTAND IN A PARK POOL & BECAME SUCKED INTO A PIPE COVERED BY A BROKEN GATE. SHE SPENT FOUR MINUTES UNDER THE WATER UNTIL SHE WAS RESCUED.
Pre-VGBA	I02B0343A	2002	Spa	Unspecified	28	Male	Body	A MALE, AGE 28, WAS BRUISED & COULD HAVE DROWNED DURING SPA USE. THE SUCTION OUTLET CAUSES A SUCTION VACUUM DUE TO HYDRAULIC RESTRICTIONS IN THE PLUMBING SYSTEM. RESPONDENT BELIEVES THE SPA VIOLATES THE NSPI STANDARD.
Pre-VGBA	X0431308A	2002	Pool	Hospital Admission	11	Male	Body	THE 11-YEAR-OLD BOY WAS SUCKED ONTO THE SWIMMING POOL'S 12 INCH BY 18 INCH INTAKE VENT. HE HELD HIS BREATH FOR 1 TO 2 MINUTES WHILE A LIFEGUARD AND BYSTANDER JUMPED INTO THE POOL TO RESCUE HIM. THE SLIDE'S PUMP WAS SHUT OFF AND THE BOY WAS RELEASED AND RESCUED. THERE WAS NO AUTOMATIC SHUT-OFF. HE WAS TAKEN TO THE HOSPITAL BY PARAMEDICS. HE SUFFERED ECCHYMOSIS, CONTUSION, AND ABRASIONS TO HIS BACK.
Pre-VGBA	C0660019A	2006	Pool	Hospital Treated and Released	11	Female	Body	A GIRL, AGE 11, NEARLY DROWNED IN A SWIMMING POOL AT AQUATIC CENTER, WHEN SHE BRUSHED AGAINST THE DRAIN & THE COVER OF IT FELL OF. THE PUMPING SYSTEM BEGAN TO SUCK HER IN. THE GIRL WAS REMOVED FROM THE POOL WITH BADLY BRUISES.
Pre-VGBA	N0670635A	2006	Spa	Hospital Admission	14	Male	Body	A BOY, AGE 14, WAS HOSPITALIZED AFTER HE GOT SUCKED INTO THE BOTTOM OF A HOTEL HOT TUB. A GRATE AT THE BOTTOM OF THE TUB BECAME DISLODGED, CREATING A STRONG SUCTION THAT PULLED HIM UNDERWATER.
Pre-VGBA	N0870491A	2008	Pool	Death	14	Female	Limb	A GIRL, AGE 14, DIED FROM BRAIN INJURY AFTER SHE WAS PULLED FROM THE BOTTOM OF A SWIMMING POOL AT A CONDOMINIUM COMPLEX. HER ARM BECAME STUCK IN THE DRAIN AT THE BOTTOM OF THE POOL AFTER SHE & TWO OTHER FRIENDS CLIMBED A FENCE TO GET INTO THE POOL.
Pre-VGBA	X08A0697A	2008	Pool	Death	6	Female	Body	THE 6 YEAR OLD FEMALE DECEDENT WAS FOUND FACEDOWN OVER THE DRAIN IN APAR™ENT COMPLEX SWIMMING POOL IN 9 FEET OF FRESH WATER.

VGBA	Incident Report Number	Year	Type	Injury	Age	Gender	Scenario	Incident Narrative
VGBA	X0960167A	2009	Pool	Death	38	Male	Body	A 38 YEAR OLD MAN DROWNED IN A HEALTH CLUB SWIMMING POOL. HE DROWNED IN 10 FEET OF WATER AFTER HE BECAME ENTRAPPED IN THE SUCTION OF THE SWIMMING POOL DRAIN.
VGBA	N0960404A	2009	Pool	Hospital Treated and Released	14	Male	Body	A 14-YEAR-OLD MALE VICTIM NEARLY DROWNED WHEN HE BECAME ENTRAPPED IN THE DRAIN AREA OF A LARGE WATERFALL AT A SWIMMING POOL OF A FAMILY MEMBER'S APAR™ENT COMPLEX. THE VICTIM, WEARING A T-SHIRT AND SWIMMING SUIT, WAS TAKING HIS TURN BACKING UP THE DRAIN FOR THE WATERFALL AND LETTING THE SUCTION HOLD HIM TO THE SIDE OF THE POOL- WHICH MANY OF HIS FAMILY MEMBERS HAD DONE BEFORE HIM. FOUR ADULTS TRIED TO PULL THE VICTIM OUT OF THE WATER, BUT HE WAS RETRIEVED FROM THE ENTRAPMENT ONLY AFTER THE WATER PUMPS TO THE WATERFALL WERE TURNED OFF. THE VICTIM WAS REVIVED AT THE SCENE AND APPEARS TO HAVE SUSTAINED NO PERMANENT INJURIES. AT THE TIME OF THE INCIDENT, NEITHER THE MAIN POOL DRAIN NOR THE WATERFALL DRAIN HAD COMPLIANT VGB DRAIN COVERS OR ANY TYPE OF SUCTION RELIEF DEVICES INSTALLED.
VGBA	X0970231A	2009	Pool	Doctor visit	7	Female	Body	THE SEVEN-YEAR-OLD FEMALE VICTIM SUSTAINED A LARGE BRUISE TO HER INNER LEFT THIGH WHEN THE SUCTION FROM A 1.5" SUCTION OUTLET SERVING A 1.5 HP PUMP, SUCKED HER LEFT LEG UP AGAINST THE WALL OF A LAZY RIVER AT A PUBLIC WATER PARK. SHE WAS PULLED UNDER WATER FOR SEVERAL SECONDS. HER 11-YEAR-OLD FEMALE COUSIN HELPED FREE THE VICTIM FROM THE SUCTION OF THE PIPE. THE VICTIM'S MOTHER TOOK HER TO HER PHYSICIAN THE NEXT DAY TO DOCUMENT HER INJURY.
VGBA	I1030083A	2010	Spa	Hospital Treated and Released	4	Female	Body	A 4 YOF SAT ON THE INTAKE FOR A SPA FILTER AT A MOTEL AND BECAME ENTRAPPED. THE VICTIM WAS PINNED IN A SITTING POSITION ON THE DRAIN WHICH WAS LACKING A COVER. THE WATER WAS FOUR INCHES DEEP AND HER HEAD WAS NOT SUBMERGED. SHE WAS TREATED AND RELEASED A LOCAL HOSPITAL WITH BRUISES ON HER LOWER BODY. SHE HAS RECOVERED WITHOUT COMPLICATIONS. THE SPA PUMP WAS NOT EQUIPPED WITH A VACUUM SAFETY RELEASE SYSTEM.
VGBA	110713CWE6003	2011	Pool	Doctor visit	4	Male	Body	A FOUR-YEAR-OLD MALE RECEIVED SEVERE BRUISING TO THE RECTAL AREA WHEN HE WAS ENTRAPPED ON AN UNCOVERED DRAIN IN AN IN-GROUND WADING POOL. THERE WERE NO OTHER INJURIES IN THIS INCIDENT.
VGBA	120110CAA1339	2011	Spa	First aid (2 victims)	12	Female	Body	A TEN YEAR OLD MALE AND A TWELVE YEAR OLD FEMALE SUSTAINED LACERATIONS, CONTUSIONS AND ABRASIONS TO THEIR BACKS AFTER BECOMING ENTRAPPED ON THE DRAIN COVER AND SUBMERGED WHILE IN A 25 PERSON HOT TUB/SPA OF AN IN-DOOR WATER PARK FACILITY. BOTH VICTIMS, WHO ARE COUSINS, RECEIVED FIRST AID AT THE SCENE OF THE INCIDENT BUT NO OUTSIDE MEDICAL TREA™ENT WAS SOUGHT AT THE TIME OF THE INCIDENT.
VGBA	X1270190A	2012	Pool	Hospital Admission	3	Female	Body	A 3-YEAR OLD FEMALE WAS ENTRAPPED ON AN UNCOVERED SINGLE DRAIN INSIDE A WADER POOL. THE DRAIN COVER CAME OFF THE DRAIN. IT WAS DETERMINED THAT ONLY TWO SCREWS INSTEAD OF FOUR SECURED THE DRAIN COVER TO THE DRAIN. THE SAFETY VACUUM RELEASE SYSTEM (SVRS) DID NOT ACTIVATE. THE OWNER OF THE POOL SHUT OFF THE SVRS AND PUMP USING A SECONDARY ON/OFF SWITCH AND THE CHILD WAS IMMEDIATELY RELEASED. THE CHILD WAS TAKEN TO A HOSPITAL WHERE SHE WAS TREATED FOR A PROLAPSED RECTUM. SHE WAS RELEASED THE NEXT DAY.
VGBA	X1940626A	2019	Pool	No Injury	3	Male	Limb	3 YOM WAS TRAPPED IN A SWIMMING POOL FILTER AT AN APAR™ENT COMPLEX. FIREFIGHTERS RESCUED HIM AND THERE WERE NO INJURIES REPORTED.

TAB C: Market and Economic Considerations for Petition to Classify Vacuum Diffusion Technology as an "Other System" Under the Virginia Graeme Baker Pool and Spa Safety Act

TAB C

United States
CONSUMER PRODUCT SAFETY COMMISSION
4330 EAST WEST HIGHWAY
BETHESDA, MD 20814

Memorandum

Date: May 7, 2020

TO: Matthew Brookman, P.E.
Project Manager, Vacuum Diffusion Technology Petition
Directorate for Laboratory Sciences
Division of Mechanical Engineering

THROUGH: Gregory B. Rodgers, Ph.D.
Associate Executive Director
Directorate for Economic Analysis

Robert L. Franklin
Senior Staff Coordinator
Directorate for Economic Analysis

FROM: Susannah Proper
Economist
Directorate for Economic Analysis

SUBJECT: Market and Economic Considerations for Petition to Classify Vacuum Diffusion Technology as an "Other System" under the Virginia Graeme Baker Pool and Spa Safety Act

Introduction

On June 23, 2015, the Commission docketed a petition (VGBA 15-1) from PSD Industries LLC (Petitioner), requesting that the Commission classify vacuum diffusion technology (VDT) as an anti-entrapment device or system under the Virginia Graeme Baker Pool and Spa Safety Act (VGBA). The Commission voted to deny the petition. Petitioner resubmitted the petition on August 27, 2019 (CPSC 19-024), with additional supporting materials and explanation, including results of third party testing conducted by Penn State University's Applied Research Laboratory. The petitioner asserts that "VDT demonstrably and unequivocally prevents hair, limb, and mechanical entrapments." Additionally, the petitioner asserts that protection against full-body

entrapment is not a requirement for VDT to be "equally effective as, or better than" the enumerated anti-entrapment systems under the VGBA.

This memorandum provides information on the market for anti-entrapment devices and systems and the economic considerations related to the petition. The analysis is based on information that is readily available, including information provided by the petitioner, public comments, and public websites of government agencies, as well as information from pool and fish pond equipment manufacturers and retailers.[30]

Background

The Virginia Graeme Baker Pool and Spa Safety Act (VGBA) requires public pools and spas with a single blockable drain to have installed one or more of six specified devices or systems, which are designed to prevent suction entrapment by pool or spa drains. The anti-entrapment devices and systems specified in 15 U.S.C. 8003 are:

> *(I) Safety vacuum release system*
> *A safety vacuum release system which ceases operation of the pump, reverses the circulation flow, or otherwise provides a vacuum release at a suction outlet when a blockage is detected, that has been tested by an independent third party and found to conform to ASME/ANSI standard A112.19.17 or ASTM standard F2387.*
> *(II) Suction-limiting vent system*
> *A suction-limiting vent system with a tamper-resistant atmospheric opening.*
> *(III) Gravity drainage system*
> *A gravity drainage system that utilizes a collector tank.*
> *(IV) Automatic pump shut-off system*
> *An automatic pump shut-off system.*
> *(V) Drain disablement*
> *A device or system that disables the drain.*
> *(VI) Other systems*
> *Any other system determined by the Commission to be equally effective as, or better than, the systems described in subclauses (I) through (V) of this clause at preventing or eliminating the risk of injury or death associated with pool drainage systems.*

The petitioner seeks to have VDT included as an "other system" for purposes of VGBA compliance. The petitioner proposes that VDT be defined as "*a system that removes the intense vacuum draw from the intake point of a pumping system by occluding the intake orifice in main drains and diffusing the vacuum from a potential blockage immediately and in multiple directions from the blockage. To be considered Vacuum Diffusion Technology, by blocking 50% of the VDT device, the system should not raise the normal vacuum draw by more than .4" Hg. Vacuum Diffusion Technology devices may not be bypassed without the use of a tool for removal as with drain covers, do not require calibration and contain no electronics or moving parts that may malfunction.*" If determined to be an "other system," a VDT product could be installed in a

[30] The petitioner's device is marketed for agriculture and fish pond use, as well as for pool and spa safety. See http://psdindustries.com/. There are other suppliers of similar devices for those applications.

public pool or spa with a single blockable drain to make it comply with the VGBA's requirements.

Market for anti-entrapment devices

There are about 309,000 public swimming pools in operation in the United States. Additionally, there are another 10.4 million residential swimming pools and about 6 million hot tubs in operation in the United States, according to data from the Pool and Hot Tub Alliance, formerly the Association of Pool & Spa Professionals and National Swimming Pool Foundation. There are about 2,500 new commercial pool and hot tub installations per year, and about 400,000 new residential installations. The service life of pools and spas, particularly for commercial installations, can exceed 25 years. The VGBA and federal regulations apply specifically to public pools and spas, although many states and localities require new residential installations to comply with similar requirements.

All public pools and spas must comply with the requirements of the VGBA, even if they were manufactured or installed before the effective date of the Act. Pools and spas with a single blockable drain must be fitted with a VGBA-compliant drain cover and be equipped with a secondary anti-entrapment device as specified in the VGBA; usually this is a safety vacuum release system or a pump shutoff system, which are the common retrofits used for existing pools and spas to achieve VGBA compliance. Gravity drainage systems and suction-limiting vent systems are generally used in new pool construction only. All of these secondary systems are intended to at least protect bathers from full body entrapment against the drain.

Petitioner asks the Commission to approve its VDT device as a secondary anti-entrapment device primarily for existing public pools and spas with a single blockable drain. Typically, new pools and spas will be built without a single blockable drain. Therefore, new pools and spas would not be required to install a secondary anti-entrapment device to achieve VGBA compliance. There are thousands of public pools and spas still in operation that have a single blockable drain and that continue to require secondary anti-entrapment device to comply with the VGBA. Additionally, there are potentially millions of pre-2009 residential pools and spas with single blockable drains still in operation, which might require a secondary anti-entrapment device to meet state or local requirements. Individual owners also may want to install such systems to reduce entrapment hazards. If VDT were approved by the Commission as an "other system," the owners of existing public pools and spas would be able to use VDT to comply with the VGBA, and may use it as an option when the safety vacuum relief system (SVRS) or other anti-entrapment device is nearing the end of its service life.

Potential Impact of Granting the Petition for Pool Owners

The petitioner claims that a representative VDT device costs "approximately 1/5th the cost of the least expensive SVRS, has no electronics or moving parts to maintain, does not require calibration, maintenance, or monthly testing." That cost estimate seems plausible, at least for the petitioner's device. The manufacturer's suggested retail price for the petitioner's patented device is about $70; although, we found it available on several Internet retailer sites for under $15. It is

essentially a piece of sieved PVC plastic that fits into the pipe inside the sump below the drain cover. (See Figure 1). Additionally, because there are no moving parts, annual maintenance costs would be negligible because the maintenance costs for the petitioner's device would be tied in with drain cover and sump maintenance that is already performed. It is also likely that the service life of the VDT, which is essentially a piece of PVC, could be at least the 5-7 years that is common for VGBA-compliant drain covers. Thus, the cost to the pool owner would be at least $14 per year, assuming the device costs $70 and lasts for 5 years, plus installation costs (discussed below).

Figure 3 - the ProteKtor™

In contrast, a small pool safety vacuum release system (SVRS) retails for about $400 from discount pool supply retailers, while more capable SVRSs and automatic pump shutoff devices may cost up to $1,200. Some SVRS or automatic shutoff technologies are integrated into the pump itself, which can run more than $2,000. Although the petitioner's VDT device would require very little maintenance, many states mandate that SVRS's in public pools and spas must be tested every month and re-calibrated. With 15 minutes of maintenance per month, an SVRS would cost about $179 per year in labor ($59.52[31] *.25 * 12), plus about $20 annually for supplies (silicon lubricant, thread seal tape, spare plugs for pool maintenance) to maintain. Thus, the cost for pool owners of an SVRS would be at least $279 annually, including the cost of the SVRS itself ($400 or more) and the maintenance costs, assuming the SVRS lasts 5 years. If the SVRS has to be replaced during that period, the annual cost could be higher. (The typical warranty for an SVRS is 3 years.) As discussed above, the annual cost to pool owners for the VDT devices offered by the petitioner would be at least $14 per year.

For both types of devices, there would also be installation costs. The installation cost would depend largely on local skilled labor costs. The amount of labor required would vary, depending on the pool configuration, the type of device, and whether the pool was already drained for the season. The VDT requires an adapter glued to the pipe; the VDT is then simply screwed into place. In contrast, the SVRS installation would require cutting pipe, gluing, and calibrating. In theory, the more simple VDT installation process could take less time (and therefore, less labor cost) than installing a SVRS. However, because pool technicians might be more familiar with SVRS installation, VDT could take more time to install.

At this time, the public can purchase the petitioner's VDT device without the CPSC action requested. However, VDT currently cannot be used to achieve VGBA compliance. If VDT could be used to achieve VGBA compliance, the cost of compliance would likely be far less than the other devices and systems specified in 15 U.S.C. § 8003. This could be particularly beneficial to small hotels and gyms. However, some states require an SVRS or gravity drainage as the only acceptable secondary safety systems. In those states, even if CPSC allowed the use

[31] U.S. BLS Q 2 2019 hourly rate for total compensation for service-providing industries.

of the VDT for VGBA compliance, this would not provide any cost savings for public pool and spa owners.

Impact on Injuries and Injury Costs

CPSC staff is aware of seven in-scope body entrapments and one limb entrapment incident that occurred since the enactment of the VGBA (See incident analysis memo). Although the petitioner has provided some test information and specifications of a specific VDT product that could theoretically protect against limb entrapments if the drain cover is missing, we cannot determine from the information provided that a generic VDT device would have prevented any of these specific entrapments. All of the recent hair entrapments occurred with the drain cover in place; so none of the existing secondary devices would have prevented these entrapments, nor would VDT have prevented them. Although the petitioner presented some evidence that the ProteKtor,™ device could protect against limb entrapment if the drain cover is missing, the petitioner states that VDT is not effective at preventing full body entrapment. As discussed in staff's hazard analysis memo, based on the reported incidents, CPSC staff identified body entrapment as the most frequent type of entrapment in comparison to limb entrapments. Accordingly, staff believes that if VDT is used as a secondary system in place of technologies such as SVRS, there could be an increase in incidents involving full body entrapment. The petitioner's device could be effective against some form of entrapment, such as limb entrapment, but the device will not be effective against body entrapment. Given there are more body entrapments in the incident data, existing VGBA secondary systems potentially address related entrapment injuries and costs more effectively than VDT. Therefore, granting the petition could potentially increase the number of injuries and injury costs.

Summary of Potential Economic Impacts of Determining VDT to be an "Other System"

VDT could be a far-cheaper option than the other devices and systems specified in 15 U.S.C. § 8003 for secondary anti-entrapment. The petitioner's device does appear to be far cheaper to purchase and maintain than any of the current devices and systems specified in 15 U.S.C. § 8003. In addition, the petitioner's device potentially has a longer service life than at least some of those VGBA-enumerated systems. There are other companies with fish protection devices similar to the petitioner's VDT product that could enter the pool/spa market, increasing competition and providing even lower VDT prices in the long term. In the short term, approving VDT as an "other system" for VGBA compliance could increase demand for available VDT devices and temporarily increase the market price.

For owners of public pools and spas, VDT would potentially represent a cheaper method of achieving and maintaining VGBA compliance. For owners of residential pools and spas, who are not required to comply with VGBA requirements for secondary anti-entrapment devices, VDT is already available for retail purchase. Therefore, granting the petition would have no impact, unless designating petitioner's device as an "other system" increases demand based on perceived safety benefits. However, the impact of widespread adoption of VDT on entrapment injuries and the associated costs are unknown. The ProteKtor™ could be effective in preventing

limb entrapment when the drain cover is missing; but the petitioner does not claim that the device is effective against full body entrapment. As discussed, staff believes that if there was widespread adoption of the petitioner's device, in place of technologies like SVRS, there could be an increase in incidents involving full body entrapment, which could potentially increase the number of injuries and injury costs.

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