STANDARDS UPDATE NOTICE (SUN)
ISSUED: January 3, 2019

STANDARD INFORMATION

Standard Number: NSF/ANSI 50
Standard Name: Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities
Standard Edition and Issue Date: 2017 Edition, dated August 25, 2017
Date of Revision: 2017 Edition, dated August 25, 2017; 2016a Edition, dated December 30, 2016; 2016 Edition, dated February 19, 2016; 2015 Edition, dated January 26, 2015
Date of Previous Revision of Standard: 2014 Edition, dated June 6, 2014

EFFECTIVE DATE OF NEW/REVISED REQUIREMENTS

Effective Date: **October 1, 2019**

IMPACT, OVERVIEW, AND ACTION REQUIRED

Impact Statement: A review of all Listing Reports is necessary to determine which products comply with new/revised requirements and which products will require re-evaluation. **NOTE:** Effective immediately, this revised standard will be exclusively used for evaluation of new products unless the Applicant requests in writing that current requirements be used along with their understanding that their listings will be withdrawn on Effective Date noted above, unless the product is found to comply with new/revised requirements.

Overview of Changes

The 2015 Edition includes:

- Addition of test requirements of **multispeed or variable pumps**
- Addition of evaluation and test criteria specific to **heater and cooler products**
- Revisions to material requirements for **swimming pool water contact materials and swimming pool treatment materials**

The 2016 Edition includes:

- Additional material compatibility and data plate requirements for **ozone generation process**
- **equipment**
- Updated control panel display requirements for **ultraviolet (UV) light process equipment**
- Correction to the required test methods for evaluation of **mechanical chemical feeders**
- Addition of standard requirements specific to **flow metering devices**

The 2016a Edition includes:

- Changes to performance testing for **recessed automatic surface skimmers**
- Updated requirements for **flow-through chemical feeding equipment**
- Updated requirements regarding voltage for **centrifugal pumps**
- Updates to the test procedures for filters, centrifugal pumps, recessed automatic skimmers, flow-through chemical feeding equipment and automated chemical controllers

The 2017 edition includes

- Updated **filtration media** requirements
- Updated disinfection efficacy and data plate requirements **for ozone generation and ultraviolet light process equipment**
- Changes to the test method for **water quality testing devices**
- Addition to **flow metering device sections** to account for units used where specific gravity is greater than 1.0
- Addition of **maximum pool water concentrations for metals**
- Updated exposure criteria for use in toxicity calculations for swimming pool treatment chemicals and contaminants

If the applicable requirements noted in the table are not described in your report(s), these requirements will need to be confirmed as met and added to your report(s) such as markings, instructions, test results, etc. (as required).

Client Action Required:

Information – To assist our Engineer with review of your Listing Reports, please submit technical information in response to the new/revised paragraphs noted in the attached or explain why these new/revised requirements do not apply to your product (s).

Current Listings Not Active? – Please immediately identify any current Listing Reports or products that are no longer active and should be removed from our records. We will do this at no charge as long as Intertek is notified in writing prior to the review of your reports.

STANDARD INFORMATION

- New additions to the standard are shown in blue
- Language removed from the standard shown in red with ~~strikethrough~~
- New requirements for which additional evaluation or testing may be necessary (depending on applicability to the listed product) are shaded in light gray

CLAUSE	VERDICT	COMMENT
The following changes reflect the revisions in the 2015 Edition		
1.5 & 4.5	Update (references)	Updated --- reference ~~IAPMO, PS-33-2010c. *Flexible PVC Hose for Pools, Hot Tubs, Spa, and Jetted Bathtubs*~~ to ANSI/IAPMO Z1033-2015. *Flexible PVC Hoses and Tubing for Pools, Hot Tubs, Spas, and Jetted Bathtubs*
3	---	~~Material Formulation~~ Swimming pool water contact materials and swimming pool treatment chemicals
3.1	---	~~General~~ Swimming pool water contact materials
---		Materials shall not sustain permanent damage or deformation when subject to repeated handling associated with the routine operation and maintenance of the equipment. Materials intended to be in contact with swimming pool or spa/hot tub water shall not impart undesirable levels of contaminants or color to the water, as determined in accordance with Annex A. The following items are exempt from the material review procedures described in Annex A: • swimming pool and spa/hot tub components with a surface area less than 100 in2 (650 cm2) in direct contact with water; • swimming pool components with a mass less than 1.4 oz (40 g); • spa/hot tub components with a mass less than 0.07 oz (2 g); • components made entirely from materials acceptable for use as a direct or indirect food additive in accordance with 21 CFR 170-199 (Food and Drugs); • glass (virgin, not recycled); • series AISI 300 stainless steel; • titanium alloy grade 1 and 2; • coatings and components made from materials acceptable for use in contact with potable water in accordance with NSF/ANSI 14 (potable water material requirements), NSF/ANSI 42, NSF/ANSI 51, or NSF/ANSI 61. In order to be qualified under NSF/ANSI 14, 42 or 61, the surface area to water volume ratio of the intended use conditions should meet the requirements of NSF/ANSI 61 when evaluated to the total allowable concentration (TAC) requirements of the standard; and

CLAUSE	VERDICT	COMMENT
		~~• treatment chemicals that conform to the requirements of NSF/ANSI 60.~~ • Materials listed under the United States Code of Federal Regulations, Title 21 (Food and Drugs) Part 189 Substances prohibited for use in Human Food, shall not be permitted as ingredients within material contacting pool, spa, and/or hot tub water. This includes arsenic, beryllium, cadmium, mercury, or thallium. Lead should also not be used as an intentional ingredient in any water contact material except for products meeting the US Safe Drinking Water Act definition of lead free (≤ 0.25% weighted average lead content).
3.2	---	**Swimming pool treatment chemicals**
---		Swimming pool treatment chemicals shall be evaluated in accordance with the requirements of Annex R and shall not impart undesirable levels of either chemical constituents or contaminants to the water. Swimming pool treatment chemicals under this Standard shall be: • the swimming pool treatment chemical constituents; • the product-specific contaminants identified in the formulation review or by testing; and • other constituents as identified in the formulation review or by testing.
3.2.1	---	**Formulation submission**
---		The manufacturer shall submit, at a minimum, the following information for each swimming pool treatment chemical: a) a proposed maximum dose rate for the product; b) complete formulation information, which includes the following: • the composition of the formulation (in percent or parts by weight for each chemical in the formulation); • the reaction mixture used to manufacture the chemical, if applicable; • Chemical Abstracts Registry Number (CASRN), chemical name and supplier for each chemical present in the formulation; and • a list of known suspected impurities within the treatment chemical formulation and the maximum percent or parts by weight of each impurity; c) a description or classification of the process in which the treatment chemical is manufactured, handled and packaged.

CLAUSE	VERDICT	COMMENT
3.2.2	---	**Formulation review**
		The formulation information provided by the manufacturer shall be reviewed and this review shall determine the formulation-dependent chemical constituents required to be evaluated in accordance with Annex R. For those swimming pool treatment chemicals that have regulatory approval for use in pools by the USEPA under the Federal Insecticide, Fungicide, Rodenticide Act (FIFRA), such regulatory approval may be used to exempt the swimming pool treatment chemical constituents from evaluation against the requirements of Annex R; however, contaminant testing and evaluation shall still be required as set forth under section 3.2.3.
3.2.3	---	**Contaminant testing**
---		Swimming pool treatment chemicals shall be tested according to the test methodologies in NSF/ANSI 60 Annex B and analyzed for contaminants per the requirements of NSF/ANSI 60, sections 3, 4, 5, 6, and 7 regarding minimum test batteries and formulation dependent analytes. Any identified contaminants shall not exceed criteria developed using Annex R.
6.6.	---	Pump performance curve
6.6.2		**Test requirements for multispeed or variable pumps** The actual pump curve, as determined in accordance with Annex C, section C.1, shall be within a range of -3% to +5% of the total dynamic head or -5% to +5% of the flow, whichever is greater, indicated by the performance curve. Data taken above 90% full flow shall not be judged to the acceptance criteria. Pumps with more than one operating speed shall be tested as documented below: • Fixed multispeed pump or motor assemblies, test at each speed; or • Variable speed pump or motor assemblies, test at 100%, 50%, and the lowest speed.
22	---	**Heat exchangers, heaters, coolers, and solar water heating systems**
22.1	---	**General** The requirements in this section apply to devices utilized to increase or decrease the temperature of pools, spas, and other recreational waters. Some examples of products addressed by this section include metal and or plastic heat exchangers, heaters, coolers, and solar radiant panel collectors and associated components such as fittings, couplings, and valves.
22.1.1		Sections of the heater that may require inspection or service shall be accessible.
22.1.2		Heaters shall be marked or labeled for proper assembly/installation and operation.
22.1.3		Replacement parts for the heater shall fit the heater without a need for undue alteration of the heater or replacement part.
22.1.4		Heaters shall comply with the material formulation requirements in 3.2.
22.1.5		Heaters shall comply with the corrosion resistance requirements in 3.3.
22.2	---	**Performance** Heater and associated components shall meet the applicable performance requirements of this section based upon their design and construction including related components such as fittings, couplings, valves, controllers, etc.

CLAUSE	VERDICT	COMMENT
22.2.1		**Dimensional conformity test** Heaters and associated components under pressure shall be evaluated for dimensional conformance with the piping and fitting dimensions recommended by the manufacturer.
22.2.2		**Hydrostatic pressure test** Heaters and associated components under pressure shall be capable of withstanding a hydrostatic pressure test at 150% of the rated working pressure test per Annex B.
22.2.3		**Cyclic pressure test** Heaters and associated components under pressure shall be capable of withstanding 20,000 cycle low/high/low cyclical pressure test per Annex B.
22.2.4		**Design burst hydrostatic pressure test** Heaters and associated components under pressure shall be capable of withstanding a hydrostatic pressure test at 200% of the rated working pressure test per Annex B.
22.2.5		**Elevated temperature hydrostatic pressure test** Heaters and associated components under pressure shall be capable of withstanding a hydrostatic pressure test at 200% of the rated working pressure when tested at 140 °F (60 °C).
22.2.6		**Head loss curve** Manufacturers shall make available a head loss curve for the equipment and associated components. Equipment and associated components shall not exceed the head loss indicated by the manufacturer's head loss curve when tested in accordance with manufacturer's installation orientation and plumbing design.
22.3		**Operation and installation instructions** The manufacturer shall provide written operation and installation instructions with each unit. The instructions shall include drawings, charts, and parts list necessary for the proper installation, operation, repair and maintenance of the heater and its associated components. The operation and installation instruction shall contain the following information: • a heater's maximum flow rating (LPM, GPM) shall be specified to mitigate erosion damage, as directed by the manufacturer; • a heater's minimum flow rating (LPM, GPM) shall be specified to prevent overheating or scale formation as directed by the manufacturer; • a warning that the heater equipment shall be installed in full compliance with the manufacturer's recommendations as well as the local regulatory and building code requirements for gas supply, plumbing, electrical connections, air exchange and ventilation. Corrosive chemicals should be stored away from the heater to minimize potential damage to the exterior of the heater; • a warning that the heater equipment shall not be installed immediately after the injection point for low pH or acidic chemicals to minimize potential corrosive damage to the inside of the heater;

CLAUSE	VERDICT	COMMENT
		• reference to recommended use chemicals, maximum and minimum concentrations (i.e., salt level, total alkalinity, calcium hardness, etc); • applicable caution and warning statements shall be prominently displayed; Example – If system flow is allowed to stagnate in a solar collector there is a potential risk of high water temperatures. Consider draining the system otherwise water in solar collectors can reach high temperatures and create hot liquid/gas. If hot liquids or gas are not purged from the system it could adversely affect plumbing, or the safety of swimmers near water return fittings. • instructions or guidance for proper size selection and installation; and • applicable diagrams and a parts list to facilitate the identification and ordering of replacement parts or other supply and installation needs.
22.4		**Marking and product identification** The heater shall be clearly and permanently marked or labeled with the following: • manufacturer name and address or website; • model number; • serial number, date code, or other means to identify date of production; • whether the unit was evaluated for pools and/or spas, if not evaluated for both applications; • working pressure; • size or capacity; • flow direction (if applicable); • maximum head loss; and • maximum design flow rate
Annex R		**Toxicology review and evaluation procedures for swimming pool treatment chemicals** *Full method not included in this document but must be referenced as needed to evaluate all applicable products as required by revisions shown above*
Annex C.4	Removal	~~**Pump curve and energy efficiency performance**~~
The following changes reflect the revisions in the 2016 Edition		
2	---	**Definitions**
2.24	---	**coolant flow rate:** The flow rate of the coolant used to remove heat from the reaction chamber(s) of the ozone generator. NOTE – The critical factor for heat removal is the mass flow rate (kg/hr) of the coolant. The mass flow rate of the coolant is equal to the volumetric flow rate (m^3/hr, ft^3/hr) of the coolant times the density (Kg/m^3,lb/ft^3) of the coolant. For liquid cooled systems the density of the coolant (liquid) is virtually independent of temperature and pressure and can be specified as the volumetric flow rate of the cooling liquid (m^3/hr, ft^3/hr, gpm, Lpm).

CLAUSE	VERDICT	COMMENT
		For gas cooled systems the density (and therefore the mass flow rate) of the coolant gas is dependent on temperature and pressure. For this Standard, the pressure and temperature ranges are small. The volumetric flow rate (m^3/hr, ft^3/hr, Ipm, ft^3/m, CFM) of the coolant shall be specified. As a practical approximation of the mass flow rate.
2.29	---	**dew point (dew-point temperature):** The temperature saturation (assuming air pressure and moisture content are constant). For Corona Discharge ozone generation greater than 2 grams per hour the minimum dew point is -76 °F (-60 °C). For systems less than 2 grams per hour, the minimum dew point is -40 °F (-40 °C). NOTE – For systems less than 2 grams per hour, the amount of nitric acid produced is negligible.
2.37	---	**feed gas:** The gas (ambient air, dry air or oxygen) delivered to the inlet side of the ozone generator. The required quality and feed gas flow rate is determined by the manufacturer.
2.38	---	**feed gas flow rate:** The flow rate of the feed gas through the reaction chamber(s) of the ozone generator. NOTE – The critical factor for the reaction is the mass flow rate (kg/hr) of the feed gas. The mass flow rate is the volumetric flow rate (m^3/hr, ft^3hr) of the feed gas times the density (kg/m^3, lb/ft^3) of the feed gas. The density of a gas is dependent on the temperature and pressure. Because of the continuous variability of the parameters affecting density and volumetric flow rate in an ozone generator, there is no practical method to determine the true mass flow rate of the feed gas. For this Standard, due to the small range of pressure and temperature, the volumetric flow rate is specified as an approximation of the mass flow rate. For pressurized systems, the manufacturer specifies the volumetric flow rate and the gauge pressure of the feed gas at the inlet to the ozone generator.
2.78	---	~~**ozone generator:** A device that causes ozone to be formed.~~
2.82	---	**ozone concentration**: The amount of ozone in the gas stream leaving the generator. Concentration may be reported by any of the following: weight percent, g/m^3, volume percent, ppm by weight, ppm by volume, and the milligrams of ozone per liter of gas produced. Under this Standard, concentration will be reported by weight percent and g/m^3.
2.83	---	**ozone generator:** A device that when supplied with an oxygen containing gas and power, produces an ozone-containing gas. Said ozone generator includes any controls, transformers and frequency generators required to convert a standard electrical supply (as specified) to the electrical characteristics required to operate the generator cell properly.
2.84	---	**ozone generator cell pressure**: The gauge pressure of the feed gas in the reaction chamber(s).
2.85	---	**ozone output rate**: The mass of ozone produced by an ozone generator in

CLAUSE	VERDICT	COMMENT
		weight per unit time (g/hr, lb/hr). Output rate is the mass of ozone per volume of product gas (g/m^3, lb/ft^3) multiplied by the feed gas flow rate (m^3/hr, lpm, ft^3/hr, CFM).
2.86	---	**ozone short cycle or batch system:** Systems that are not designed to operate for more than 5 min at a time.
2.87	---	**packaged ozone system**: An ozone generator packaged with a gas preparation system, typically on a single skid or otherwise a single unit.
2.101	---	**relative humidity**: The ratio, in percent, of the actual amount of water vapor in a body of air in relation to the maximum amount that the body can hold at a given temperature. Relative humidity varies with temperature for a given amount of water vapor.
13	---	**Ozone generation process equipment**
13.9	---	**Compatible materials for operation**
13.9.1		For use of alternate materials, at a minimum the supplier shall confirm compatibility with end use. Other materials may be used for construction of ozone generators if proper material compatibility is demonstrated. Acceptable documentation shall include component material manufacturer's compatibility charts or written warranty statement. Tables 13.9.2 and 13.9.3 provide examples of ozone-resistant materials that are commercially available. These materials are recommended for use with dry gas with a maximum temperature of 104 °F (40 °C). Alternate materials may be used for ozone generators if material compatibility is demonstrated (see section 13.18 Life test). The material supplier shall provide documentation of compatibility including component material manufacturer's compatibility charts or written warranty statement. Ozone resistant materials not in Table 13.9.2 and 13.9.3 shall be tested in accordance with Annex G, Section G.1.
13.23	---	**Data plate**
---		Data plate(s) shall be permanent; easy to read; and securely attached, cast, or stamped onto the unit at a location readily accessible after normal installation. Data plate(s) shall contain the following: – caution statements (prominently displayed) including a statement that the unit is designed for ~~supplemental~~ secondary disinfection and should be used with an EPA registered ~~or approved~~ disinfection chemicals to impart ~~required~~ a measurable residual concentrations in the water.
14	---	**Ultraviolet (UV) light process equipment**
14.4 15.4 16.4 17.4	---	**Flow ~~meter~~ metering device**
14.5	---	**Performance indication**
---		Each system shall incorporate on the control panel a constantly visible readout of the actual flow (in gpm), the actual calculated dose (in mJ/cm^2) and the actual lamp intensity (in w/cm^2).

CLAUSE	VERDICT	COMMENT
		~~The process equipment shall be provided with an effective means to alert the user when a component of this equipment is not operating.~~
14.8	---	**Disinfection efficacy**
---	Exemption	Process equipment designed for ~~supplemental~~ secondary disinfection shall demonstrate a 3-log reduction of influent bacteria when tested according to Annex H. Equipment that has been successfully evaluated to the requirements of this section to demonstrate 3-log or greater inactivation of *Cryptosporidium parvum* are exempt for the requirement of Annex H.
14.12	---	**Life Test**
---	Correction	When tested in accordance with the life test described in Annex I, a minimum of 8000 operating hours shall be accumulated among the three units; no less than 3000 operating hours shall be accumulated on one of the three units. At the conclusion of the testing, the units with 3000 operating hours shall be evaluated to the ~~output~~ operational protection, pressure, and disinfection efficacy requirements of this section.
15	---	**In-line electrolytic chlorinator or brominator process equipment**
15.15	---	**Life Test**
---	Clarification	When tested in accordance with the life test described in Annex I, a minimum of 8000 operating hours shall be accumulated among the three units; no less than 3000 operating hours shall be accumulated on one of the three units. At the conclusion of the testing, the units with 3000 operating hours shall ~~perform as intended by the manufacturer~~ be evaluated to the ~~output~~ delivery, pressure, and operational protection requirements of this section.
17	---	**Copper/silver and copper ion generators**
17.14	---	**Life Test**
---	Clarification	When tested in accordance with the life test described in Annex I, a minimum of 8000 operating hours shall be accumulated among the three units; no less than 3000 operating hours shall be accumulated on one of the three units. At the conclusion of the testing, the units with 3000 operating hours shall ~~perform as intended by the manufacturer~~ be evaluated to the ~~output~~ delivery, pressure, and operational protection requirements of this section.
20	---	**Spas and hot tubs**
20.2	---	**Materials**
20.2.2	---	Flexible reinforced (helical or fabric) plastic spa hose shall meet the requirements of this Standard and IAPMO ~~PS 33~~/ANSI Z1033.
20.4	---	**Design and Construction**
20.4.1	---	**General**
---		Spas marked as “outdoor use”, “indoor and outdoor use”, or not marked shall have the exterior surface of spa sealed to prevent leakage or splashing and precipitation of spa water into the mechanical equipment in accordance with ANSI/UL 1563, Water exposure test, section 54.2 Splashing, 54.3 Seal test and 54.4 Simulated rain.
20.6	---	**Air blower and air induction systems**
20.6.4	---	**Materials**
20.2.2	---	Air blower tubing shall meet or exceed the tubing performance requirements of this Standard or IAPMO ~~PS 33~~/ANSI Z1033.

CLAUSE	VERDICT	COMMENT
23	---	**Flow metering device**
23.1	---	**Scope** The purpose of this section is to specify the evaluation and testing criteria to enable appropriate assessment of a flow metering device for material health safety, corrosion resistance, durability, operating pressure rating, pressure loss, and flow measurement accuracy.
23.2	---	**Performance testing** The product shall be tested and certified in accordance with the requirements in this Standard.
23.3	---	**Evaluation and testing criteria**
23.3.1	---	**Limitations and variations**
---		Flow measuring devices shall operate in orientations and configurations of piping including pipe diameter size (i.e., size such as 2” schedule 40 PVC), orientations (such as horizontal, vertical flowing upward, downward, etc.), and configurations (such as installed near elbows or in straight pipe runs) specified by the manufacturer.
23.3.2	---	**Electrical components**
---		Flow measurement devices that utilize electrical components shall comply with the relevant electrical safety standard requirements based upon protocol design and the electrical safety standards and code requirements of the authority having jurisdiction.
23.4	---	**Design, construction and performance requirements**
23.4.1	---	**General** Flow measuring devices shall be designed and constructed to facilitate inspection, maintenance, servicing and cleaning.

CLAUSE	VERDICT	COMMENT
23.4.2	---	**Outdoor use**
---		Flow measuring devices marketed as “outdoor use”, “indoor and outdoor use”, shall have the exterior surfaces sealed to prevent damage from environmental exposure of sun and rain and shall be tested in accordance with the requirements in Annex S – Flow metering device outdoor use. Products not recommended by the manufacturer for outdoor use shall not require rain or UV testing nor product marking relative to indoor or outdoor use.
23.4.3	---	**Accessibility**
---		Flow measuring device components shall be installed in an accessible location for viewing, inspection, maintenance, repair, or replacement.
23.5	---	**Fastener evaluation**
---		When metal fasteners are used, they shall be ANSI 316 stainless steel or a better alloy grade for corrosion resistance. All fasteners that provide access to replaceable parts or service areas shall be tested for 15 cycles of insertion/removal without damage, and shall have at least 3 threads of engagement.
23.6	---	**Working pressure and pressure testing**
---		Flow metering devices shall have a minimum working pressure of 345 kPa (50 psi) as claimed by the product manufacturer. Pressure testing shall be performed in the following sequence on one unit or product (hydrostatic pressure, cyclic pressure, then burst pressure).
23.6.1	---	**Hydrostatic pressure testing**
---		Conduct testing at 1.5 times the manufacturer claimed working pressure in accordance with Annex B.1.4.
23.6.2	---	**Cyclic pressure testing**
---		Conduct cyclical pressure testing for 20,000 cycles of 0 kPa – 207 kPa – 0 kPa (0 psi – 30 psi – 0 psi) in accordance with Annex B.1.4.
23.6.3	---	**Pressure testing**
---		Conduct testing at 2.0 times the manufacturer claimed working pressure in accordance with Annex B.1.4. There shall be no rupture, leakage, burst or permanent deformation of the flow metering device.
23.6.4	---	**Design pressure**
---		The design burst pressure of a flow metering device shall be at least four times the working pressure. As an alternative to design calculation, the product shall be tested to the design burst pressure with a rate of pressure increase such that the design burst pressure is reached within 90 seconds.
23.7	---	**Head loss**
---		The head loss through a flow metering device shall not exceed the manufacturer’s maximum design head loss when determined in accordance with Annex S – Flow metering devices head loss.
23.8	---	**Flow rate measurement accuracy**
---		Flow metering device flow rate accuracy testing shall be performed with all manufacturer recommended pipe sizes, orientations, and configurations.
23.8.1	---	**Orientation**
---		Flow rate accuracy testing shall be performed with the flow metering device installed in each of the following orientations unless such an installation is not

CLAUSE	VERDICT	COMMENT
		recommended by the manufacturer's installation instructions: – horizontally oriented with water flow; – vertically oriented with water flowing upward; and – vertically oriented with water flowing downward.
23.8.2	---	**Configuration**
---		Flow rate testing shall be performed with the flow metering device installed in each of the following configurations unless such an installation is not recommended by the manufacturer's installation instructions: – with straight pipe run lengths of 20 (twenty) times the nominal pipe diameter before and after the flow metering device, or less as recommended by the manufacturer; and. – with 90° elbows placed within 6 (six) inches (15.2 cm) of the flow metering device or at closest recommended distance before and after the flow metering device as recommended by the manufacturer.
23.9	---	**Flow metering device testing and accuracy levels**
---		Flow metering device accuracy testing shall be performed using an NIST traceable flow metering device accurate to ± 4 Lpm (± 1 US gpm) or 2% of reading each point of the flow (whichever is greater). Devices that indicate flow rates with non-digital, discrete flow rate values shall be tested at eight flow rates indicated by their discrete markings to assess accuracy within the claimed flow range. Devices that indicate flow rates with a digital display shall be tested at 8 different flow rates, at the lowest, highest, and 6 different flow rates dispersed throughout the claimed flow rate range. Results shall be reported in a table and graph and show the deviation from actual flow rates at each of the tested points throughout the manufacturer claimed flow rate range. Results of flow measurement testing shall meet one of the following accuracy requirement categories. For level 1 (L1) flow metering device: – average of the absolute values of all single point deviators shall be ≤ 2.0%; and – single point deviations shall not exceed ± 4.0%. For level 2 (L2) flow metering device: – average of the absolute values of all single point deviations shall be ≤ 5.0%; and – single point deviations shall not exceed ± 7.5%. For level 3 (L3) flow metering device: – average of the absolute values of all single point deviations shall be ≤ 10%; and – single point deviations shall not exceed ± 12.5%. For level 4 (L4) flow metering device: – average of the absolute values of all single point deviations shall be ≤ 12.5%; and – single point deviations shall not exceed ± 15%.

CLAUSE	VERDICT	COMMENT
		For level 5 (L5) flow metering device: – average of the absolute values of all single point deviations shall be ≤ 15%; and – single point deviations shall not exceed ± 20%.
23.10	---	**Display flow rate scale range**
---		The meter's readable flow velocity range shall be from a minimum of 2 feet per second (FPS) (5 cm/s) to 10 fps (25.4 cm/s) or greater.
23.11	---	**Display resolution**
---		For linear display scales, the meter display shall be a minimum of 2.00 inches (50.8 mm) in linear length. For circular displays, the meter display shall be a minimum of 6.30 inches (160 mm) in circumference. There shall be a minimum of 10 measurement points displayed on the scale. The minimum distance between the measurement points shall be 0.20 inches (5.08 mm). The scale reading line thickness shall be a minimum of 0.020 inch (0.05 cm) thick. For digital displays, the minimum digit height shall be 0.20 inches (5.08 mm). The display shall indicate to within 1 US gpm or a value equal to at least 10% of the lowest scale reading.
23.12	---	**Life testing**
---		Flow metering devices with moving parts shall be tested after the equivalent of 5 years of use or 5,000 cycles of actuation (such as mechanical actuation of full sweep of the indicator) on one flow metering device unit. The aged sample shall be tested in at least one of the installation configurations and methods noted in 23.9 Flow rate measurement accuracy. The test results of the aged and non-aged sample shall be compared. The average of the absolute value of all single point deviations from the aged sample shall not exceed the absolute value of all single point deviations of the un-aged sample by more than 2 (two) times the absolute value of the un-aged sample.
23.13	---	**Product marking or data plate**
---		Flow metering devices shall have a data plate that is permanent and easy to read. A durable tag (such as metal or plastic) may be used in lieu of data plate due to size availability for data plate to be on product. The data plate shall have, at a minimum, the following information: – manufacturer's name (or trademark) and address or website, – model designation or number; – production date, date code or serial number; – working flow rate range (i.e., 20 – 100 US gpm) (76-379 Lpm) if not visible when looking elsewhere on the product; – accuracy level (i.e., level 1 or L1) if not visible when looking elsewhere on the product; – maximum working pressure; – allowable connection or pipe size(s) including schedule; – indoor/outdoor use (if recommended by the manufacturer and the product meets UV/Rain requirements) if the manufacturer does not recommend outdoor installation, the product shall be marked "Indoor Use Only". – certification mark attesting to compliance with all requirements.
23.14	---	**Installation and operation manual**

CLAUSE	VERDICT	COMMENT
---		A manual shall be provided with each flow metering device and shall include: – instructions for installation, including details of acceptable pipe sizes, piping configurations, installation orientations, etc.; – any non-recommended piping sizes, configurations and installation orientations, etc; – instructions for use; – head loss for each allowable or recommended piping size, configuration, and installation; – working flow rate range (i.e., 20 – 100 US gpm) (76 – 379 Lpm) if not visible when looking elsewhere on the product; – accuracy level (i.e., Level 1 or L1) if not visible when looking elsewhere on the product; – maximum working pressure; – trouble shooting guide (if applicable); – instructions for service and serviceable components and parts (if applicable); – manufacturer recommended replacement parts (if applicable); and – contact information for the manufacturer or service company.
Annex A	---	**Materials review and qualification methods**
A.3.2	---	**Selection of parameters for exposure testing**
---	Procedural Update	Analysis for phenolic substances and total organic carbon (TOC) may be used as screening tests to determine whether additional testing is warranted for specific potential contaminants. Exposure testing may also be conducted to determine whether a material may impart color to water.
Annex F	---	**Test methods for the evaluation of mechanical chemical feeders**
F.4.5	Correction	**Acceptance criteria** At least one of the three mechanical chemical feeders shall complete 3000 satisfactory operating hours, and a minimum of 8000 satisfactory operating hours shall be accumulated among the three units. At the conclusion of the testing, the units shall perform as intended by the manufacturer and shall continue to conform to the uniformity of output, suction lift, and hydrostatic pressure requirements in Annex F, ~~section F.5.~~
Annex H	---	**Test methods for the evaluation of process equipment**
H.1	---	**Disinfection efficacy of secondary disinfection equipment**
H.1.6	---	**Evaluation**

CLAUSE	VERDICT	COMMENT
H.1.6.4	Update	**Acceptance criteria** After each of five complete turnovers, the test unit shall achieve a 3 log reduction for challenge organisms. Performance shall be noted in the manufacturer's installation and operating instructions ~~and be noted in Certification listings per 11.7~~.
H.3	---	**Ozone production test**
H.3.2	---	**General test conditions**
H.3.2.2	---	**Gas preparation equipment**
---	Removal of unnecessary measurements	The feed gas for a packaged ozone generator shall be the output of the packaged gas preparation equipment. ~~The feed gas dew point and oxygen concentration shall be measured and reported.~~ The input gas to the gas preparation equipment shall be the ambient air at the laboratory.
H.3.2.3	---	~~**Corona discharge ozone generators**~~
---	Removal of unnecessary measurements	~~The feed gas shall be 93 ± 2% oxygen by weight with a maximum dew point of 112 °F (-80 °C) or less. Ambient oxygen concentration decreases as the elevation above sea level increases. The performance of an ozone generator that uses air as the feed gas decreases with decreasing oxygen concentration in the feed gas. The manufacturer shall provide information about the performance of the ozone generator with feed gas oxygen concentration different from test conditions in this Standard~~
H.3.2.4	Removal of unnecessary measurements	~~**UV**~~ Ozone generators ~~UV ozone generators~~ shall be tested under ambient air conditions at the laboratory. All test conditions (including ambient temperature, relative humidity, and ~~ambient oxygen concentration~~ elevation above sea level) shall be documented.
H.3.4	---	**Ozone production procedure**
H.3.4.1	Removal of unnecessary measurements	An ozone generator shall be set up and conditioned according to the manufacturer's specifications. Prior to testing the ozone generator shall be purged using the feed gas at the design flow rate for a minimum of 2 h, or as specified by the manufacturer, ~~or until the specified dew point and oxygen concentration are achieved~~. The generator cell pressure range shall be measured and reported. 1) The generator cell pressure ~~operation range shall be specified by the manufacturer. The generator cell pressure~~ shall be reported. 2) The type and quality of feed gas source shall be in accordance with the manufacturer's specifications. 3) A minimum of two feed gas flow rates shall be tested. Feed gas flow rate shall be set according to the manufacturer's instructions. The feed gas flow rate shall be recorded in volume per unit time. NOTE – If the gas flow rate of the generator is not adjustable, the ozone generator may be tested at its specified gas flow rate 4) For an ozone generator with a liquid coolant, the coolant specified by

CLAUSE	VERDICT	COMMENT
		the manufacturer shall be used. The coolant flow rate shall be set in accordance with the manufacturer's instructions.
H.4	---	**Ozonation – live *Cryptosporidium parvum* oocysts reduction**
H.4.3	---	**Reagents**
---	Procedural Update	– DABCO-glycerol mounting medium (2%) – 2 g 1, 4 diazabicyclo [2.2.2] octane shall be added to 95 mL of pre-warmed glycerol using a magnetic stirring bar on a heating stir plate. The final volume shall be adjusted to 100 mL with additional glycerol. This solution shall be dated and stored at room temperature and shall be discarded after six months.
H.4.8	---	**Evaluation**
H.4.8.3.3.3	---	**Dilutions**
---	Procedural Update	– 10X dilutions: Oocysts shall be diluted by removing 100 µL from first tube and transferring it to a second. Serial dilutions shall continue. Tubes shall b vortexed briefly between each dilution transfer. Tips shall be changed between each transfer. – 5X dilutions: Oocysts shall be diluted by removing 200 µL from first tube and transferring it to a second. Serial dilutions shall continue. Tubes shall be vortexed briefly between each dilution transfer. Tips shall be changed between each transfer.
Annex I	---	**Lifetest**
I.3	---	**Water temperature**
---	Update for consistency purposes	~~NOTE 1 – All feeders, except those labeled to be for swimming pools only, shall be tested at the spa/hot tub water temperature.~~ ~~NOTE 2 – If scientific evidence exist that temperature may affect the efficacy of a technology, the worse-case scenario shall be used.~~
I.4	---	**Method**
---	Update to account for products not intended for continuous operation	a) Assemble three units according to the manufacturer's instructions. b) Connect the units to a re-circulating tank filled with water conditioned to the applicable temperatures specified in Annex I, section I.1.3. ~~Adjust the pressure source to obtain a pressure that is 80 ± 0.5% of the maximum rated pressure. Set the output rate to deliver a minimum of 80% of the rated output specified by the manufacturer.~~ c) Start the units and allow them to operate per manufacturer's instructions continually for a period of 3000 h. ~~Maintain the units in accordance with the manufacturer's maintenance instructions. Manufacture shall not specify parts replacement as maintenance within 3000 h.~~ Units that are not designed for continuance operation shall be set at the maximum allowable daily operation time. The total test period shall remain 3000 hours. If the output is also variable in addition to the daily operation time, it shall be set to the level specified in c). d) Maintain the units in accordance with the manufacturer's maintenance instructions. Manufacturer shall not specify parts replacement as

CLAUSE	VERDICT	COMMENT
		maintenance within 3000 h.
I.5	---	**Acceptance criteria**
---	Update to account for products not intended for continuous operation	Units designed for continuous operation: At least one of the three units shall complete 3000 satisfactory operating hours, and a minimum of 8000 satisfactory operating hours shall be accumulated among the three units. At the conclusion of the testing, the units shall ~~perform as intended by the manufacturer and shall continue to conform~~ be evaluated to the applicable performance requirements as specified in the products life test section. Units not designed for continuous operation: At least one of the three units shall complete 3000 total elapsed hours, during which the daily operation time is set to the maximum level. A minimum of 8000 total elapsed hours shall be accumulated among the three units, during which the daily operation time is set to the maximum level. At the conclusion of the testing, the unit with 3000 operating hours shall be evaluated to the applicable performance requirements as specified in the products life test section.
Annex J	---	**Equipment – recommendations for installation and operation**
J.6.4	---	**Residual disinfection**
	Update (procedural)	Ozone is a very efficient oxidizing agent. However, it is very difficult to maintain a measurable ozone residual in the pool water. It is recommended that a chemical such as chlorine or bromine be added after treatment with ozone as a residual disinfectant, at levels mandated by state and local regulations. The oxidizing of organics by ozone prior to application of the residual disinfectant helps prevent the formation of undesirable halogenated byproducts. There are ozone removal methods that may be considered prior to the addition of the chemical disinfectant: – degassing by means of aerated flow; ~~and~~ or – Ultraviolet radiation; or – granular activated carbon filter. Ozone process equipment should be placed upstream of the ozone removal methods cited above. Halogenation equipment should be placed downstream of ozone removal methods.
J.6.5	---	**Off-gassing**
---	Update (editorial)	Ozone is considered toxic above certain concentrations in air. If the ozone concentration in the water exceeds the equilibrium state, the excess ozone will be emitted into the air. The Occupational Safety and Health Administration has set a short-term exposure limit of 0.3 ppm (0.6 mg/m3) and longterm exposure limit 0.1 ppm (0.2 mg/m3) time weighted average, over 8 h/d, 5 d/week. When the equipment is located in an enclosed room, consideration should be given to having adequate exhaust in case of ozone releases. The exhaust system should provide a minimum of three air changes per hour to comply with the OSHA limits. In addition, an ambient air ozone monitor should be installed.

CLAUSE	VERDICT	COMMENT
		Ozonation systems, which operate under vacuum, should not present a danger of ozone leaks into the treatment room.
Annex O	---	**Water quality testing devices**
O.1	---	**Test method for Water Quality Testing Devices (WQTD)**
O.2	---	**Stock solution preparation**
---	Update (procedural)	e) Bromine Stock Solution: Dilute 1 ml of a 3% bromine solution to 100 ml. Determine actual bromine concentration by dilution and DPD method (e.g., Hack 8016).
Annex Q	---	**Recommended water quality maintenance for spas**
Q.1	---	**Sanitizer levels**
---	Informative	1) Free chlorine (ppm) a) minimum 2.0 b) ideal 3.0 – 5.0 c) maximum 10.0 Maintain these levels continually during hours of operation. Test water before use. During extended use, test water hourly. Shock treat water after use. 2) Combined chlorine (ppm) a) ideal 0.0 – 0.2 High combined chlorine results in reduced sanitizer efficacy. Take remedial action to reduce combined chlorine. Other signs of combined chlorine: sharp chlorinous odor and eye irritation (e.g., mucous membranes). 3) Total bromine (ppm) a) minimum 2.0 ~~30~~ b) ideal 4.0 – 6.0 ~~30 – 50~~ c) maximum 10 ~~50~~ Hot water/heavy use may require operation at or near maximum levels. Regular oxidation is recommended. Test water before use. During extended use test water hourly. Shock treat water after use. 4) PHMB (ppm) Polyhexamethylene biguanide a) minimum 30 b) ideal 30 – 50 c) maximum 50 Certain classes of pool chemicals or treatment processes are incompatible with PHMB sanitizer. The pool or spa owner should consult with the supplier of PHMB if there is any question about compatibility of an auxiliary

CLAUSE	VERDICT	COMMENT
		chemical or process. These include, but are not limited to: a) chlorine/bromine sanitizers b) copper-based algicides c) monopersulfate (peroxymonosulfate) oxidizers d) phosphate-based chealtors and detergents e) electrolytic chlorinators f) copper/silver ionizers When used with ozone, follow manufacturer's directions; consult pool professional or test kit manufacturer for appropriate test kit; regular oxidation is recommended.
Annex S	---	**Flow metering devices outdoor use**
S.1	---	**Rain and precipitation**
---		Flow measurement devices with electrical components and for outdoor use shall be evaluated for resistance to damage from rain and precipitation by conducting tests from ANSI/UL 1563 prior to conducting flow metering device accuracy testing. Flow metering devices with electrical components for outdoor use shall meet ANS/UL 1563 requirements for Water exposure test, Section 54.2 Splashing, 54.3 Seal test and 54.4 Simulated rain.
S.2	---	**UV exposure**
---		Flow measurement devices for outdoor use which are constructed of polymeric parts that would be exposed after installation shall have the polymeric materials evaluated for UV degradation of plastics in accordance with ANSI/APSP-16 for UV exposure and strength retention. The UV exposed plastic materials or parts shall maintain at least 70% of the impact and tensile strength of unexposed plastics to evidence compliance with UV exposure and resistance requirements.
Annex T	---	**Flow metering devices head loss**
T.1	---	**Head Loss**
		Test the flow measuring device with manufacturer recommended piping type(s) and size(s). The device shall be installed with 20 (twenty) times the nominal pipe diameter in straight pipe runs before and after the flow metering device. There shall be 10 (ten) times the nominal pipe diameter before the pressure measurement point on the influent side of the device and 5 (five) times the nominal pipe diameter prior to the pressure measurement location on the effluent side of the device. Head loss values shall be recorded at 8 (eight) points evenly distributed across the entire claimed flow range of the device. The head loss results shall be within 10% of the manufacturer claimed head loss.
T.2	---	**Head loss test**
T.2.1	---	**Purpose** The purpose of this test is to verify that the head loss caused by the flow measurement device does not exceed the maximum head loss as specified by the manufacturer, and to verify that the head loss of the device throughout its operational range.
T.2.2	---	**Apparatus** – pressure recording device (required accuracy is ± 0.5 of the smallest division

CLAUSE	VERDICT	COMMENT
		used in the manufacturer's claimed pressure loss); – turbidimeter (required accuracy from 0 to 10 NTU is ± 0.5 NTU; required accuracy above 10 NTU is ± 5% of the reading or ± 1 NTU, whichever is greater); – temperature indicating device (required accuracy is ± 2 °F (± 1 °C); – flow metering device (required accuracy is ± 1 US gpm (± 4 Lpm) or ± 2% of reading, whichever is greater); – water tank and pump system capable of delivering water at the design flow rate and proper temperature; and – pressure measurement taps sized to the piping inlet and outlet.
T.2.3	---	**Challenge water** Water temperature = 75 ± 10 °F (24 ± 6 °C); Turbidity = ≤ 2 NTU
T.2.4	---	**Method** a) Install a pressure measurement tap before and after the flow measurement device. The taps should be connected by a hose to the pump outlet and return. Determine the head loss due to any restriction between the flow measurement device inlet or outlet and the installed pressure measurement taps. This head loss should be subtracted from the head loss measured during operation. b) Install and condition the flow measurement device in accordance with manufacturer's instructions and initiate water circulation at the design flow rate. c) Operate the unit at the design flow rate for 300 ± 30 s taking four (4) recordings evenly spread within the manufacturer's claim flow rate including a recording at the minimum and maximum points within the range. d) Measure and record the inlet and outlet static pressure. e) Calculate the head loss using one of the following equations: HLF = (P1 - P2) + [Z1 x (9.81) W]/1000 – HLP HLF = [(144 x (P1 - P2))/W] + Z1 – HLP Where: HLF = head loss due to filter (ft); P1 = inlet static pressure (psig); P2 = outlet static pressure (psig); W = specific weight of water (lb/ft^3); Z1 = height of inlet centerline above outlet centerline (ft); and HLP = head loss due to piping from P1 to P2 (ft). NOTE – conversions HLF (m) x 9.81 = HLF (kPa) HLF (ft) x 0.4335 = HLF (psi) P (psi) x 2.307 = P (ft)

CLAUSE	VERDICT	COMMENT
		Or Where HLF = head loss due to filter (kPa); P1 = inlet static pressure (kPa); P2 = outlet static pressure (kPa); W = density of water (kg/m^3) Z1 = height of inlet centerline above outlet centerline (m); and HLP = head loss due to piping from P1 to P2 (kPa). This analysis assumes that the inlet and outlet piping are of the same size, material, and general condition. If this is not the case, these factors shall be taken into account.
T.2.5		**Acceptance criteria** The measured head loss shall not exceed the design head loss specified by the flow metering device manufacturer.
The following changes reflect the revisions in the 2016a Edition		
6	---	**Centrifugal pumps**
6.6	---	**Pump performance curve**
6.6.1		For each pump model or model series, the manufacturer shall provide a pump performance curve that plots the pump's total dynamic head versus the discharge flow rate. The manufacturer shall also have a curve available that plots the net positive suction head (NPSH) or total dynamic suction lift (TDSL), brake horsepower, and pump efficiency in relation to the performance curve. Pumps with a rating of 5 HP (3.7 kW) or less are not required to have a NPSH curve. For pumps utilizing motors rated for multiple voltages, if the pump performance curve varies between rated voltages, such as may occur between 230v and 208v, the manufacturer shall provide a pump performance curve for each rated motor voltage.
9	---	**Recessed automatic surface skimmers**
9.4	---	**Equalizer line**
9.4.3		When the skimmer is operating at the maximum design flow rate and the water level is lowered to 2 in (51 mm) below the lowest overflow level of the weir (see Annex E, section E.2.4.~~e~~g), ~~the flow rate through the~~ equalizer line (if provided) shall ~~be within ± 5% of the maximum design flow rate~~ prevent air from being entrained in the pump suction line (see Annex E, section E.4).
9.8	---	**Head Loss**
---		The actual head loss of a skimmer in normal operation shall not exceed the head loss indicated by the manufacturer's head loss claim by more than 5% or 0.25 psi, whichever is greater (see Annex E, section E.4). If a trimmer valve is present, the head loss shall be measured with the trimmer both 100% open, and again with the trimmer valve 50% open.

CLAUSE	VERDICT	COMMENT
		If a skimmer is equipped with an equalizer line, the actual head loss of a skimmer in equalizer operation shall not exceed the head loss indicated by the manufacturer's head loss claim by more than 5% or 0.25 psi, whichever is greater (see Annex E, section E.4)
9.9	---	**Operation and installation instructions**
9.9.1		The manufacturer shall provide written operation and installation instructions with each unit. The instructions shall include drawings, charts, head loss curves, and parts lists necessary for the proper installation, operation, and maintenance of the skimmer.
11	---	**Flow-through chemical feeding equipment**
11.3		**Hydrostatic pressure** Flow-through chemical feeders shall show no evidence of rupture, leakage, burst, or permanent deformation when subjected to a hydrostatic pressure 1.5 times the manufacturer's maximum pressure rating (see Annex G, section G.2). The unit tested shall be one that has been exposed in accordance with the chemical resistance test per Annex G, section G.1 for a test period of 100 d.
Annex B	---	**Test methods for the evaluation of filters**
B.4	---	**Filter media cleanability test**
B.4.3.1	Correction	**Swimming pool / spa / hot tub filter applications** Tap water with 0.04 ± 0.01 lb of ball clay22, 189 mg baby oil23, and 0.04 ± 0.01 lb of diatomaceous earth (for non DE filters) added for every gallon per minute of flow rate at which the filter is tested (4.8 ± 1 g of ball clay, 50 mg of baby oil, and 4.8 ± 1 g of diatomaceous earth added for every liter per minute). No diatomaceous earth is added to the challenge slurry when testing a diatomite-type filter.
B.5	---	**Turbidity reduction test**

CLAUSE	VERDICT	COMMENT
B.5.4	Update (procedural)	**Turbidity reduction test method** b) Sample the water in the tank and determine the turbidity level (TB1) in NTU. Add a sufficient quantity of silica #140 to obtain a turbidity level (TB2) of 45 ± ~~10~~ 5 NTU.
Annex C	---	**Test methods for the evaluation of centrifugal pumps**
C.1	---	**Performance curve verification**
C.1.4	---	**Performance curve verification method** a) Pump shall be installed and operated according to the manufacturer's instructions. The manufacturer shall state the inlet conditions under which the published performance curves were established, and barometric pressure. b) Air leaks shall be avoided in the suction line. Piping shall be clean and free of scale, burrs, etc. c) The suction pipe end shall be submerged a distance of at least ten pipe diameters. Liquid around the suction pipe shall be relatively quiet, without entrained air, swirls, etc., from recirculated discharge. d) The suction and discharge gauge/manometer lines shall be purged so that the suction gauge line is free of water and the discharge gauge line is free of air. e) The test shall be conducted with normal rated voltage ~~(± 10%)~~ (± 5%) at motor terminals.
Annex E	---	**Test methods for the evaluation of recessed automatic skimmers**
E.4	---	~~**Flow to pump test – equalizer performance**~~ **Skimmer head loss and equalizer performance test**
E.4.1	---	Purpose The purpose of this test is to verify that the head loss of a skimmer during normal or equalizer operation does not exceed the head loss specified by the manufacturer and to verify that a skimmer's equalizer device will prevent air from entering the suction line of the circulation system ~~and will maintain the proper flow rate in the suction line when the water level drops below the lowest overflow level of the skimmer weir.~~
E.4.2	---	Apparatus — turbidimeter scaled in NTU accurate to ± 2 NTU; — temperature-indicating device accurate to ± 2 °F (± 1 °C); — adequately sized tank and pump to deliver required flow; — flow measuring device accurate to ± 3%; and — compound pressure gauge(s) conforming to ANSI/ASME B40.100 Grade 3A specifications.
E.4.4	---	Flow to pump – equalizer performance test method a) Install the skimmer to the test tank in accordance with the manufacturer's instructions. If included in the skimmer design, install any floats, check valves, or other devices associated with the equalizer line. b) Connect a flow meter to the skimmer's outlet port, and connect a compound pressure gauge to a pressure measurement tap in the piping connected to the skimmer outlet port, and to the piping connected to the skimmer equalizer port (if present). See diagram E1.

CLAUSE	VERDICT	COMMENT

c) Fill the tank to the skimmer's normal operating level and set the flow at the maximum design flow rate. Observe the return line to the test tank for any signs of air being admitted into the tank. If any air is noted, check the suction line for leaks.

d) Set the flow to 25% of the maximum design flow rate and record the flow rate ("Q", gpm) and the pressure reading ("P1", psi) from the compound gauge in the piping connected to the skimmer outlet port. Repeat these readings at 50%, 75% and 100% of the maximum design flow rate.

e) Record the elevation ("Z1", feet) of the test tank water level above the compound gauge in the piping connected to the skimmer outlet port, and calculate the head loss due to the skimmer in normal operation at 25%, 50%, 75% and 100% of the maximum design flow rate:

$$\text{Skimmer Head Loss, Normal Operation (ft)} = Z_1 - \frac{P_1}{2.307} - \frac{Q^2}{8002611 \times D_1^4}$$

where:

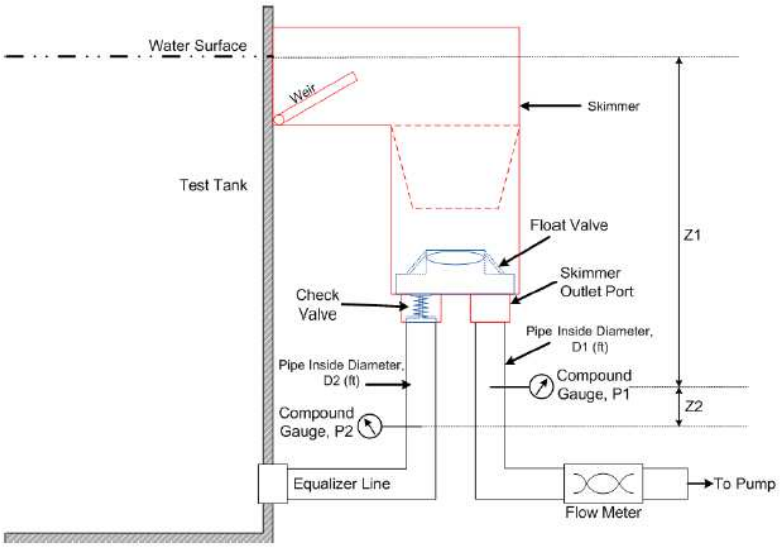
Z_1=Water Elevation (feet)
P_1=Compound Gauge Reading (psi)
Q=Flow Rate (gpm)
D_1=Pipe Inside Diameter (feet)

f) If the skimmer is equipped with an equalizer line continue to perform steps g, h, and i.

g) Lower the water level in the tank to 2 ± 0.25 in (51 ± 6.4 mm) below the lowest overflow level of the weir. There shall be no entrained air observed in the suction line after 30 s from the time the water level drops below the lowest overflow level of the weir.

h) Set the flow to 25% of the maximum design flow rate and record the flow rate ("Q", gpm), the pressure/vacuum reading ("P1", psi) from the compound gauge in the piping connected to the skimmer outlet port, and the pressure/vacuum reading ("P2", psi) from the compound gauge in the piping connected to the skimmer equalizer line. Repeat these readings at 50%, 75% and 100% of the maximum design flow rate.

i) Record the elevation ("Z2", feet) of the compound gauge in the piping connected to the skimmer outlet port ("P1") above the compound gauge in the piping connected to the skimmer equalizer line ("P2"), and calculate the head loss due to the skimmer in equalizer operation at 25%, 50%, 75% and 100% of the maximum design flow rate:

CLAUSE	VERDICT	COMMENT
		Skimmer Head Loss, Equalizer Operation (ft)$=\frac{P_2-P_1}{2.307}-Z_2-\frac{Q^2}{8002611}\left(\frac{1}{D_2^4}-\frac{1}{D_1^4}\right)$ where: P_1=Compound Gauge Reading in Skimmer Outlet Piping (psi) P_2=Compound Gauge Reading in Equalizer Piping (psi) Z_2=Elevation of P_1 above P_2 (feet) Q=Flow Rate (gpm) D_1 = Skimmer Outlet Pipe Inside Diameter (feet) D_2 = Equalizer Pipe Inside Diameter (feet)  **Figure 10 – Skimmer head loss & equalizer performance test setup (normal operation)**
E.4.5		Acceptance criteria The measured head loss through the skimmer during normal operation shall not exceed the manufacturer's published head loss by more than 5% or 0.25 psi, whichever is greater. If the skimmer is equipped with an equalizer line, the measured head loss through the skimmer during equalizer operation shall not exceed the manufacturer's published head loss by more than 5% or 0.25 psi, whichever is greater, and there shall be no entrained air observed in the suction line after 30 s from the time the water level drops below the lowest overflow level of the weir. ~~The flow rate in the suction line shall not deviate from the maximum design flow rate by more than ± 5% from the maximum design flow rate when the water level drops below the lowest overflow level of the weir.~~
Annex G	---	**Test methods for the evaluation of flow-through chemical feeding equipment**
G.1.4	---	**Chemical resistance test method** a) Install the flow-through chemical feeder in a flow loop, such that the discharge is into an open vented tank. The tank should be vented outside. b) Fill the flow-through chemical feeder to the maximum level with the applicable chemicals, or subject feeder parts to the specified chemicals by immersion. If the chemical is a dry type, fill the feeder to the manufacturer's

CLAUSE	VERDICT	COMMENT
		maximum recommended chemical level and then fill it to the maximum water level. c) To ensure that the chemical solution is in contact with each surface that is to be exposed, the feeder should be installed below the water level in the tank. d) ~~Seal all inlet and outlet ports, with the exception of one port above the flood level to allow any generated gases to escape~~. Expose the normally wetted parts to the chemical(s) for 100 d ± 6 h, by flowing water through the chemical feeder for 16 out of every 24 h and allowing the water to remain stagnant for 8 out of every 24 h. e) Examine the feeder weekly and check for any signs of leakage, damage, or any other noticeable changes. Once the test period has elapsed, drain and examine the feeder. *Note: Changes to (d) were not added until the 2017 version (Issue 135)*
G.2.4	---	**Hydrostatic pressure test method** NOTE — The method described here is primarily intended for the testing of basic erosion-type flow-through chemical feeders. Some modification may be required when evaluating differing types of flow-through chemical feeder designs. However, the intent of the method shall be maintained when these modifications are made. a) Install the feeder, previously tested in Annex G, section G.1.4, in accordance with the manufacturer's instructions.
Annex H	---	**Test methods for the evaluation of process equipment**
H.1	---	**Disinfection efficacy of secondary disinfection equipment**
H.1.6.2	Update (procedural)	**Procedure** f) The constituents specified in Annex H, section H.1.3 b) shall be added simultaneously to the test water. Add an appropriate amount of the appropriate challenge organism to obtain a minimum of 1.0 X 106 organisms per 100 mL of test water ~~(not to exceed 1.0 X 107 per 100 mL per each challenge organism).~~
Annex N	---	**Test methods for the evaluation of automated chemical controllers**
N.2.3.2	Update (procedural)	**Chlorine / Bromine** Calcium hypochlorite added as an option that may be used in Chlorine and ORP test methods in place of sodium hypochlorite
N.2.3.3.1	Update (consistency)	**Monitor display accuracy** When testing the ORP probe, the alkalinity should be in the range of 80 – 120 ppm and a pH of 7.5 ± 0.2 throughout all tests. The temperature should remain constant (room temperature) throughout the duration of all of the tests ± 3 °F. a) Weigh 0.20 g of 5% sodium hypochlorite solution. Quantitatively transfer to a 1 L volumetric flask and dilute to volume using de-ionized water. The resulting stock solution should contain approximately 10 ppm available chlorine. b) Volumetrically dilute the stock sodium hypochlorite solution by the appropriate proportions to give the following four solutions: 1 ppm, 3 ppm, 5 ppm, and 7 ppm chlorine. c) Place ~~three~~ four ORP sensors in the solution in b) and connect them to the displays/automated controllers, or place the influent tubes from ~~three~~ four controllers in the solution, (actual samples under test, so that there will be ~~three~~ four independent senor/display setups. Calibrate them per the manufacturer's

CLAUSE	VERDICT	COMMENT
		instructions. d) At each concentration record the readings of the ~~three~~ four ORP sensors. Calculate the average of the readings at each concentration.
Annex O	Update (editorial)	**Water quality testing devices** Tables O.1-O.9 *Column titles in Tables O.1 through O.9 were updated for consistency.*
The following changes reflect the revisions in the 2017 Edition		
Title	---	Equipment and Chemicals for Swimming Pools, Spas, Hot Tubs and Other Recreational Water Facilities
1	---	General
1.1	---	This Standard covers materials, chemicals, components, products, equipment and systems, related to public and residential recreational water facility operation.
1.5	Updated	**Normative references**
2	---	**Definitions**
2.33	---	**Effective size:** The size opening that will just pass 10 percent (by dry weight) of a representative sample of the filter material
2.111	---	**Secondary disinfection:** Units that demonstrate a 3-log (99.9%) or greater reduction or inactivation of *Cryptosporidium parvum* in a single pass when tested in accordance to Section 14.18.2.
2.131	---	**Supplemental disinfection:** Units that demonstrate a 3-log (99.9%) or greater reduction of *Pseudomonas aeruginosa* and *Enterococcus faecium* when tested according to Annex H, Section H.1.
2.147	---	**Uniformity Coefficient**: A ratio calculated as the size opening that will just pass 60% (by dry weight) of a representative sample of the filter material divided by the size opening that will just pass 10% (by dry weight) of the same sample.
2.154	---	**WQTD accuracy**: Accuracy is defined as how close the WQTD result is to the reference value.
2.155	---	**WQTD precision:** Precision is defined as how close replicates of a single value are to each other.
12	---	**Filtration media**
12.2	---	**Sand filter media**
12.2.3	---	**Sand and alternate sand-type filter media**
12.2.3.1	Clarification	The manufacturer of sand and an alternate sand-type filter media shall specify the ~~particle~~ effective size and uniformity coefficient for the media. ~~Particle~~ Effective size and uniformity coefficient evaluation shall be ~~confirmed~~ performed in accordance with ASTM C136 with sieves conforming to ASTM E11. A minimum of five data points shall be measured for sizing. The particle size data shall be plotted as a smooth curve, which shall be used to read the sieve opening sizes at which 60% and 10% of particles can pass. The uniformity coefficient and effective size measured shall be ± 10% of the claimed uniformity coefficient and effective size, or shall be within the claimed range of uniformity coefficient and effective size, whichever is larger.
12.2.5		**Sand and alternate sand-type media labeling requirements**

CLAUSE	VERDICT	COMMENT
		Sand and alternate sand-type filter media shall contain the following information on the product packaging or documentation shipped with the product: — manufacturer's name and contact information (address, phone number, website, or prime supplier); — product identification (product type, and tradename); — net weight or net volume; — when applicable, mesh or sieve size; — Uniformity coefficient for particle size; — lot number or other production identifier such as a date code; — when appropriate, special handling, storage and use instructions; and — the specific certification mark of the certifying organization for certified products.
13	---	**Ozone generation process equipment**
13.1	---	**General** Ozone generation process equipment covered by this section is intended for the secondary and supplemental disinfection of the water in the circulation system of public and residential recreational water facilities, including but are not limited to: pools, and spas/hot tubs, therapy pools, and interactive aquatic play features. Since these products are not intended to produce residual levels of disinfectant within the body of water, an EPA registered disinfecting chemical shall be added to impart a measurable residual. The measurable residual disinfecting chemical shall be easily and accurately measured by a water quality device certified to section 19.
13.19		**Disinfection efficacy** Process equipment designed for ~~secondary~~ supplemental disinfection such as copper and/or silver ion generators, ozone and ultraviolet light equipment shall demonstrate a 3-log (99.9%) or greater inactivation of influent bacteria when tested according to Annex H, Section H.1. ~~Ozone systems claiming~~ Process equipment designed for secondary disinfection such as copper and/or silver ion generators, ozone and ultraviolet light equipment shall demonstrate a 3-log (99.9%) or greater reduction of *Cryptospordium parvum* ~~shall be~~ when tested and evaluated according to Section 13.20.
13.23		**Data plate** Data plate(s) shall be permanent; easy to read; and securely attached, cast, or stamped onto the unit at a location readily accessible after normal installation. Data plate(s) shall contain the following: — manufacturer's name and contact information (address, phone number, website, or prime supplier); — model number; — serial number or date of manufacture; — certification mark of the ANSI-Accredited testing and certification organization; — electrical requirements (volts, amps, hertz) for operation; — type of feed-gas;

CLAUSE	VERDICT	COMMENT
		— rated feed-gas flow rate (SCFH and/or LPM); — rated ozone production (grams/hour and/or pounds/day); — method of cooling and coolant flow rates; — level of disinfection certification (Level 1 or Level 2); — maximum daily operation time (if not designed for continuous operation); — caution statements (prominently displayed) including a statement that the unit ~~is designed for supplemental disinfection and~~ should be used with an EPA registered disinfection chemical to impart a measurable residual concentration in the water; and — a statement identifying if the unit is suitable for supplemental disinfection or for secondary disinfection.
14	---	**Ultraviolet (UV) light process equipment**
14.1	---	**General** UV light process equipment covered by this section is intended for ~~use in~~ the secondary and supplemental treatment ~~of circulation systems~~ of public and residential swimming pools and spas/hot tubs. Since these products are not intended to produce residual levels of disinfectant within the body of the swimming pool or spa, these products are intended for use with appropriate residual levels of EPA registered disinfecting chemicals. Specific residual levels of EPA registered disinfecting chemicals may be required by the regulatory agency having authority. The residual chemical shall be easily and accurately measurable by a field test kit.
14.7		**Data Plate** Data plate shall be permanent; easy to read; and securely attached, cast, or stamped onto the unit at a location readily accessible after normal installation. Data plate(s) shall contain the following: — equipment name and function(s); — manufacturer's name and contact information (address, phone number, website, or prime supplier); — model number designation; — electrical requirements for operational volts, amps, and Hertz of the unit; — serial number or year of construction; — maximum rated operating pressure in kPa (psi); — prominently displayed caution statement: "UV light is harmful to eyes and exposed skin; turn off electrical supply before opening unit."; — caution statement that the unit ~~is designed for supplemental disinfection and~~ should be used with registered or approved disinfection chemicals to impart required residual concentrations; — model and number of UV lamp(s); — maximum daily operation time (if not designed for continuous operation); — maximum design flow rate in gallons/minute (liters/minute); and — a statement identifying if the unit is suitable for supplemental disinfection or for secondary disinfection.
14.8		**Disinfection efficacy** Process equipment designed for supplemental disinfection such as copper and/or silver ion generators, ozone and ultraviolet light equipment shall

CLAUSE	VERDICT	COMMENT
		demonstrate a 3-log (99.9%) or greater inactivation of influent bacteria when tested according to Annex H, Section H.1. ~~UV systems claiming chlorine resistant organism treatment such as Cryptosporidium parvum inactivation shall be evaluated according to 14.18.~~ Process equipment designed for secondary disinfection such as ozone and ultraviolet light equipment shall demonstrate a 3-log (99.9%) or greater inactivation of *Cryptospordium parvum* when tested and evaluated according to Section 14.18.
19	---	**Water quality testing devices (WQTD)**
19.2	Procedural Update	**Testing** WQTD units selected for testing shall be from at least 2 different batches or manufacturing runs. Each lot submitted for initial testing shall have a minimum of 50% shelf life remaining at the start of the testing. Products are conditioned and/or calibrated as appropriate per the manufacturer's instructions then exposed and tested per Annex O requirements to various test solutions to evaluate their accuracy, repeatability, reproducibility, and shelf life, within specified use ranges.
19.2.3		**Test parameters** For each parameter tested, it shall meet the applicable requirements in Annex O. The WQTD shall be used to analyze test solutions within each range shown in Annex O (see Table below) if the parameter falls within the WQTDs operating range for that parameter. Test solutions shall be divided equally to test the WQTD ~~three~~ seven times at each concentration for each unit of the WQTD under test. ~~All test points shall be used to determine accuracy and the three test results shall be averaged to determine compliance with Annex O (for that parameter). The data points for each unit shall determine repeatability; data shall be compared between units to determine reproducibility.~~
19.2.4		**Accuracy within operating range (Level 1, 2, and/or 3)** Testing shall be conducted based upon the manufacturers recommended/claimed use range and the operating ranges to evaluate conformance with level L1, L2, and/or L3 requirements for each parameter. All test points shall be used to determine accuracy and the seven test results shall be averaged to determine compliance with Annex O (for that parameter).
19.2.5		~~**Repeatability or**~~ **Precision and reproducibility** ~~Test two lots of production to verify production lot variability and consistency in product performance.~~ ~~To assess reproducibility, testing of the two separate lots should occur with separate test solutions made on different days.~~ At each parameter tested, the average standard deviation in the results for each unit of a WQTD shall meet he precision requirements of Annex O, Section O.13 based on the level of the WQTD. — Test Strips: test two lots of test strips with one set of solutions. Both lots shall meet the precision requirements, and the difference between the accuracy of the first and second lot of the test strips shall meet the reproducibility requirements;

CLAUSE	VERDICT	COMMENT
		— Colorimeters / titrators / spectrophotometers: test one device with two reagent lots with one set of solutions, and test two devices with one reagent lot on a different day with a fresh mid-point solution. Both reagent lots shall meet the precision requirements, and the difference between the accuracy of the first and second lot of the reagents shall meet the reproducibility requirements. On the second day, the difference between the accuracy of the first and second devices shall meet the reproducibility requirements.
19.2.6		**Shelf life** The shelf life for the reagents and components of a WQTD shall be at least as long as specified by the manufacturer when the reagents and components are tested in accordance with Annex O, Section O.14. When tested with reagents and components stored for the manufacturer specified shelf life (± 2 weeks), the accuracy, and repeatability ~~and reproducibility~~ of the WQTD shall ~~be within 10% of the initial accuracy, repeatability, and reproducibility. For test strip/comparators the result shall be within the limits stated in~~ meet the requirements of Annex O. After initial testing of the WQTD, it shall be stored in accordance with the manufacturer's instructions and retested at the manufacturer's prescribed shelf life (± 2 weeks) for compliance to these requirements in 19 and Annex O.
23	---	**Flow metering device**
23.3	---	**Evaluation and testing criteria**
23.3.1		**Limitations and variations** Flow measuring devices shall operate in orientations and configurations of piping including pipe diameter size (i.e., size such as 2" schedule 40 PVC), orientations (such as horizontal, vertical flowing upward, downward, etc.), and configurations (such as installed near elbows or in straight pipe runs) specified by the manufacturer. The standard fluid used at recreational water facilities is water with a specific gravity of 1.00 ± .05. For applications that use a fluid other than water, flow measuring devices shall be tested using a fluid with a specific gravity equivalent to the application. For example, Floatation Tanks use water at a temperature of 98 °F (37 °C) mixed with Epsom Salts (magnesium sulphate) which results in a fluid with a specific gravity of 1.25. NSF 50 Certified flow measuring devices that are tested for these fluids shall include markings to denote that they are only intended for use with fluids of the specific gravity for which they have been tested and certified.
23.13		**Product marking or data plate** Flow metering devices shall have a data plate that is permanent and easy to read. A durable tag (such as metal or plastic) may be used in lieu of data plate due to size availability for data plate to be on product. The data plate shall have, at a minimum, the following information: — manufacturer's name (or trademark) and address or website, — model designation or number;

CLAUSE	VERDICT	COMMENT
		— production date, date code or serial number; — working flow rate range (i.e., 20 – 100 US GPM) (76-379 LPM) if not visible when looking elsewhere on the product; — accuracy level (i.e., Level 1 or L1) if not visible when looking elsewhere on the product; — maximum working pressure; — allowable connection or pipe size(s) including schedule; — indoor/outdoor use (if recommended by the manufacturer and the product meets UV/Rain requirements) if the manufacturer does not recommend outdoor installation, the product shall be marked “Indoor Use Only”; — certification mark attesting to compliance with all requirements; and — the specific gravity of the fluid used for certification if other than water (specific gravity 1.0 ± .05).
Annex A	---	**Materials review and qualification methods**
A.2	Exemption	**Formulation review** Where required for conformance to Section 3.2, complete material formulation information shall be reviewed to determine whether a material is suitable for contact with the product water, to assess the potential for contaminants to be contributed to the product water from the material, to determine whether extraction testing is warranted, and to select the appropriate extraction testing parameters. The complete formulation information may be omitted for a component material if: — the generic material type is contained in NSF/ANSI 61 Table 3.1, and the material is not a coating or filtration media, and the material is tested to the requirements of Table 3.1; or — if the material is not listed in NSF 61 Table 3.1 and the material is not a coating or filtration media, and the material is tested to the requirements of NSF 61 Table 3.2.
A.3	---	**Exposure testing**
A.3.2	Procedural	**Selection of parameters for exposure testing** The selection of potential contaminants for which testing is warranted shall be based on the review of the material formulation, the toxicological significance of the ingredients, and the likelihood of their migration. Analysis for phenolic substances and total organic carbon (TOC) may be used as screening tests to determine whether additional testing is warranted for specific potential contaminants. Exposure testing may also be conducted to determine whether a material may impart color to water. If the formulation has been omitted for a component material as allowed through Section A.2, testing shall include the material specific analyses in NSF 61, Table 3.1, or as directed in NSF 61 Table 3.2.
Annex H	---	**Test methods for the evaluation of process equipment**
H.1	---	**Disinfection efficacy of ~~secondary~~ supplemental disinfection equipment**

<table>
<tr><th>CLAUSE</th><th>VERDICT</th><th>COMMENT</th></tr>
<tr><td>H.1.1</td><td>---</td><td>Purpose
The purpose of this test is to determine the disinfection efficacy of process equipment designed for <s>secondary</s> supplemental disinfection for swimming pools and spa/hot tubs.</td></tr>
<tr><td>Annex O</td><td>---</td><td>Water quality testing devices</td></tr>
<tr><td>O.1-O.13</td><td>---</td><td>Test methods in Annex O were revised to correct and clarify issues regarding procedural requirements and acceptance criteria as well as to improve accuracy of the results obtained. The complete annex with all revisions is not included in this SUN document but will be applied accordingly if required per the revisions in Section 19 shown above.</td></tr>
<tr><td>O.14</td><td>Procedural</td><td>O.14 Shelf life testing
To verify shelf life, open or use product as required for the above testing. Upon completion of use of product close/seal/turn off, and store in accordance with manufacturer’s instructions or store at 50% relative humidity at 73 ± 8 °F (23 ± 4 °C) for the duration of the shelf life. After the shelf life time has elapsed Within a range of 2 weeks (+-) of the expiration date/shelf life claim, open/turn on etc. and conduct testing with the product for the appropriate product types or parameters. If product does not comply, the manufacturer shall revise shelf life claims, storage conditions, etc. as appropriate.</td></tr>
<tr><td>Annex R</td><td>---</td><td>Toxicology review and evaluation procedures for swimming pool treatment chemicals</td></tr>
<tr><td>R.4</td><td>---</td><td>Initial toxicity screen/threshold of evaluation</td></tr>
<tr><td>R.4.2</td><td>---</td><td>Determination of swimming pool water concentrations:
The maximum pool water concentration of each chemical constituent (or contaminant) in the product must be calculated and then initially compared to the Threshold of Evaluation as described in Section R.4.4, with the exception of the metals listed in R.4.3.</td></tr>
<tr><td>R.4.3</td><td></td><td>Maximum pool water concentrations for metals
The following metal contaminants will be limited to the Total Allowable Concentrations criteria as set forth under NSF/ANSI 60/61. Any metals listed here will be evaluated per the procedures outline in the remainder of Annex R.
Table R.1 - Limitations on metal contaminants

<table>
<tr><th>Metal</th><th>Criteria (mg/L)</th></tr>
<tr><td>antimony</td><td>0.006</td></tr>
<tr><td>arsenic</td><td>0.001</td></tr>
<tr><td>barium</td><td>2</td></tr>
<tr><td>beryllium</td><td>0.004</td></tr>
<tr><td>cadmium</td><td>0.005</td></tr>
<tr><td>chromium</td><td>0.1</td></tr>
<tr><td>lead</td><td>0.005</td></tr>
<tr><td>mercury</td><td>0.002</td></tr>
</table></td></tr>
</table>

CLAUSE	VERDICT	COMMENT
		selenium 0.005 thallium 0.002
R.5	---	**Swimming pool exposure assessment methodology** *Updated exposure assumptions were incorporated into Annex R. for use in calculation of the toxicity of swimming pool treatment chemicals and contaminants. All updated data and references are not included in this document but may include Swimming pool dermal exposures, Swimming pool oral exposures and Swimming pool inhalation exposures and will be applied accordingly per standard requirements.*
		CUSTOMERS PLEASE NOTE: This Table and column "Verdict" can be used in determining how your current or future production is or will be in compliance with new/revised requirements.