PERFORMANCE GUIDELINES FOR SINGLE USE KEGS

Best Practices for Procurement, Performance, and Use of Single Use Beer Kegs
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1. **INTRODUCTION**

1.1 The following information refers to single use beer kegs and is an industry recommendation to ensure beer keg quality and address best practices in the procurement, performance, and usage of beer kegs in North America.

1.2 This document summarizes industry accepted and recommended best practice guidance and is not intended to be used as a strict specification or standard. The brewer may address specific needs and refine these guidelines as appropriate in a written practice for themselves and for their suppliers. It is the brewer’s responsibility to be familiar with and to maintain compliance with all federal, state, and local statutes and regulations and additionally those of other countries where a brewer chooses to export.

1.3 This guideline applies to all single use kegs irrespective of their material(s) of composition or valve type. Single use means the keg is only filled once and is not returned for refill.

1.4 The separate Performance Guideline for Refillable Kegs covers industry recommendations for refillable beer kegs.

1.5 The sources for information contained below are current best practices and recommendations from brewers and suppliers, regulations and standards, and governing bodies.

1.6 Federal, state, and local statutes and regulations shall take precedent over this guideline.

1.7 We would like to thank the suppliers, vendors, technical experts, and brewers who participated and who have engaged throughout the guideline development process. Stakeholder support to continue to refine and improve this document is greatly appreciated.
2. **Key Findings**

2.1 In all cases, when a keg fails, whether in service or during any test performed, whether kegs are full, partial empty or pressurized, they should fail safe. Fail safe criteria means no fragments and no ejection of components. Fail safe criteria allows for venting of liquid or gas contents only without propulsion of the keg, valve, or any portion thereof. Fail safe criteria applies at all times throughout a kegs complete lifecycle including disposal and recycling.

2.2 Life cycle for single use kegs is one cycle. Do not re-use or re-purpose kegs after use.

2.3 Keg and component manufacturers should produce to and comply with technical drawing dimensional targets and tolerances, capacities, materials of construction, and specifications for procedures processes and protocols for bonding, welding, assembly and construction. All single use keg manufacturing protocols should satisfy the rigors of trade as prescribed whether produced from metal, plastic, or any combination of materials.

2.4 The rigors of trade for single use kegs include empty storage under variable temperature and humidity conditions, incidental exposure to line lubricants, sanitizing agents or other chemicals, shock and vibration of transport when empty and full, manual and mechanical handling including drops and impacts during moves and storage, pressurization and dispense, depressurization, final handling and disposal.

2.5 Extreme heat conditions due to direct exposure to sunlight and/or heat sources may cause single use kegs, full, partial empty or pressurized, to deform and/or fail.

2.6 Single use kegs may utilize a valve system that is only compatible with a custom filling system or that only functions with a special coupler designed for tapping that keg system at retail. Special instructions may be required for operation.

2.7 Standard industry practice for Maximum Allowable Working Pressure (MAWP) for kegs is 60 psig, the maximum pressure at which a keg should be allowed to operate. It represents the maximum gauge pressure that could develop in a keg absent venting or external cooling of the keg. This is the worst case condition for normal service. The MAWP must never exceed the Design Pressure. User must check single use keg labeling for the MAWP. U.S. refillable kegs are commonly marked with a warning that the container will rupture if pressurized above 60 psig. Single use keg manufacturers should prominently mark kegs and communicate the maximum allowable working pressure limits of their single use keg system. This is especially important when a keg’s design pressure differs from industry expectations.

2.8 To prevent keg rupture, use a pressure regulator and properly sized relief device with any pressure source to which a keg is connected. Filling and dispense systems should be set and checked regularly to maintain a pressure lower than the weakest component.

2.9 Kegs should be filled per established industry methods with good manufacturing practices in a safe manner. Keg compatibility should be verified in partnership with the keg filling system vendor to provide the optimum filling sequence to maintain keg and beer quality.

2.10 Cleaning solutions, soap, line lubricant and related brewery process chemicals especially alkaline caustic based, may be incompatible with single use kegs. Avoid contact on conveyors surfaces or incidental surface rinse at even dilute solutions and check with keg manufacturer for specific recommendations.

2.11 Single use keg and valve systems should be designed and so constructed that after emptying the internal pressure will be safely relieved and/or vented to atmospheric pressure. Precaution is required to assure venting operation is done in a safe manner with sufficient ventilation to avoid carbon dioxide build-up and risk of asphyxiation.
3. **PURPOSE**

3.1 To provide manufacturers and commercial users of single use kegs, generally sized 15 liters (4 gallons) to 60 liters (16 gallons) a guideline of minimum quality recommendations.

3.2 To facilitate the safe operation of kegs and their components throughout the brewing industry network.

3.3 To maintain positive communication between all involved parties.

4. **PURCHASING OR PROCUREMENT**

4.1 The intent of the following is to establish understanding between supplier and end user from the beginning of the purchase relationship. Brewers need to understand the manufacturer’s warranty offered on keg and keg components.

4.2 Consistent quality should be maintained from lot-to-lot, including but not limited to safety, performance, integrity, and flavor impact.

4.3 Keg manufacturers and their sales representatives should provide up-to-date detailed drawings and technical performance information for the specific product they represent.

4.4 All materials should conform to the specifications of construction as detailed by the technical drawing and specification or contractual documents.

4.5 All materials should be traceable to point of origin.

4.6 All materials, colorants, additives, and coatings that are in primary food contact in the keg system should comply with applicable FDA regulations (Title 21 CFR 177). The keg and spear supplier should make available a copy of such certification for the brewery’s record keeping.

4.7 It is recommended that keg systems be fit for purpose as defined by the brewer and the distribution system to which the product will be subjected. A brewer should understand the distribution and dispensing environment to which the keg will be subjected and select a keg system that will withstand the rigors of trade for a single trip.

4.8 It is recommended that brewers understand their beer properties such as gas volume, pH, flavor components, solids, risk of microbiological contamination and/or over carbonation with re-fermentation, and the possibility for adverse dispense conditions and ingredient interaction with the keg system being considered.

4.9 It is recommended that new kegs be purchased clean and free of contaminants both internally and externally and ready for direct beer fill.

4.10 New kegs should have no flavor, odor or physical impact on beverage products.

4.11 It is recommended that single use beer kegs only be used for storing and dispensing beer. It is not recommended that beer kegs be used for storage of chemicals or other potential contaminants (such as pesticides).
5. PERFORMANCE

5.1 Performance on Failure

5.1.1 At all times during any test performed, and during all times when kegs are in service, whether kegs are full, partial empty, empty and at any pressure, they should fail safe in all events. Fail safe criteria means no fragments and no ejection of components; vent of liquid or gas contents only without propulsion of the keg, valve, or any portion thereof. Fail safe as such is not limited to testing, but applies at all times including failure when keg is in service through complete lifecycle including disposal and recycling.

5.2 Dimensional Requirements

5.2.1 It is recommended that component manufacturers produce to and comply with technical drawing dimensional targets and tolerances, capacities, and materials of construction. Dimensional stability is required for consistent volume.

5.2.2 It is recommended that component manufacturers produce to and comply with specifications for procedures, processes and protocols for bonding, welding, assembly and construction.

5.2.3 It is recommended that component manufacturers be able to provide technical drawings, product performance descriptions, and material composition detail that represent the finished product being purchased. All parties should recognize confidentiality and protect intellectual property rights as appropriate.

5.2.4 It is recommended that component manufacturers acknowledge that all technical drawings should include a title block that contains at a minimum: drawing originator’s corporation name, a drawing title or description, a unique alphanumeric reference such as a drawing number, an issue date, and a revision alphanumeric character and a revision log.

5.2.5 All parties should recognize that any change to the information on the drawing should have a written agreement between the brewer and the keg/component manufacturer, and should result in a modification to the drawing and the title block.

5.2.6 It is recommended that component manufacturers recognize that any revision to the title block should identify the change in the unique reference, the date of the change, the description of the change, and the new version.

5.2.7 It is recommended that manufacturer’s provide cross sectional drawings depicting key dimensions of their keg. Drawings should describe suitability and compatibility for filling, dispensing, collation and stacking for effective palletization, warehousing, and transport handling.

Examples of Single Use Keg Configurations

5.2.8 Brewers should confirm keg dimension compatibility with filling equipment as well as for general fit for retail dispense systems, coolers, kegerators, and keg boxes. The following are key dimensions. Detailed dimensions to be provided by supplier.

5.2.8.1 A = Overall Height
5.2.8.2 B = Overall Diameter
5.2.8.3 C = Height of neck
5.2.8.4 D = Neck Recess (Neck to top of body clearance)
5.2.9 Single use kegs may utilize a valve system that is only compatible with a custom filling system or that only functions with a special coupler designed for tapping that keg system at retail. It is recommended that the brewer verify that the in-house filler has a coupler that will properly function for the keg system and that the retailer has a coupler that will work with the single use keg to be dispensed. Special instructions may be required for operation.

5.2.9.1 Detailed dimensions of the valve and the recommended coupler to be provided by supplier.

5.2.10 Coupler should incorporate hygienic design with a pressure relief valve as an integral part of the coupler body. When functioning with other relief devices in the system, it should prevent the keg from reaching a pressure in excess of the recommended working pressure. Coupler also allows ability to relieve pressure for troubleshooting dispensing problems.

5.3 Physical Characteristics

5.3.1 Suppliers should specify the keg (or bag system) target volume (capacity) and overflow volume with and without the appropriate spear valve. Due to the elastic nature of plastic kegs, the keg volumes and volume tolerances should be specified at a specified pressure and temperature; for example 29 psi (2 bar) at 68°F (20°C).

5.3.2 Consistent keg weight is necessary for tare weight to confirm fill weight and volume.

5.3.3 It is recommended that all containers are visually inspected both internally and externally. It is the manufacturers responsibility to validate that:

5.3.3.1 There are no sharp edges or other irregularities on the keg including at hand holes, drain holes, welds, neck, keg body, etc.

5.3.3.2 The inside product contact surfaces of kegs and spears should be smooth and free of defects including but not limited to cracks, crevices, pinholes, and/or surface imperfections which might harbor micro-organisms or affect filling and dispensing.

5.3.4 Container product contact surfaces should be free of any oil, grease, release agents, and/or foreign matter.

5.3.5 Metal beer contact surfaces such as springs in a single use keg valve should be made of food safe AISI stainless steel such as 302, 304 or 316.

5.4 Manufacturing Quality Requirements and Procedures

5.4.1 Manufacturers of direct fill kegs (no pre-wash at brewery) should produce and assemble components and kegs in a clean environment. The vendor should be able to provide documentation of quality and sanitation procedures. All process conditions and handling should be certifiable by the vendor to support direct beer filling.

5.4.2 Keg manufacturers should pre-pressurize single use direct fill kegs with a clean inert gas (CO₂ or N₂) to approximately 10-20psi. Empty new keg pressurization is to provide an indicator that the keg with an installed valve does not leak. The positive pressure should assure a clean interior, and as an inert gas, may help preserve oxygen scavenger barrier within polymer keg walls. Some keg technologies that incorporate a beer pouch with a closed valve may not utilize pre-pressurization.

5.5 Fitness and Function Testing

5.5.1 Performance testing should be conducted by manufacturers and/or independent laboratories according to parameters agreed between the brewer and the manufacturer.

5.5.1.1 Manufacturers should provide a certificate of compliance or certificate of analysis demonstrating performance to specifications by lot.

5.5.2 The objective of the recommended testing is to reconstruct the environmental conditions that a keg may experience in its distribution and use. Understanding how the keg performs under the recommended conditions should identify risks that a brewer should consider when selecting a keg system. These tests may not demonstrate performance under the most extreme conditions, but rather more typical stress challenge conditions from rigors of trade for a single trip.

5.5.3 It is recommended that testing represent environmental conditions (such as maximum and minimum temperature and pressure) experienced in brewery production, warehousing, distribution/handling, and basic intended use through retail dispense and servicing.
5.5.4 It is recommended that all testing be conducted at controlled temperature(s) and each test should include a significant time component to realistically emulate the rigors of trade of a single use keg.

5.5.4.1 Life cycle for single use kegs is one cycle.

5.5.4.2 The rigors of trade include empty storage under variable temperature and humidity conditions, shock and vibration of transport when empty and full, manual and mechanical handling including drops and impacts during moves and storage, pressurization and dispense, depressurization, final handling and disposal.

5.5.5 It is recommended that all tests be conducted in a safe location for attending operators.

5.5.6 It is recommended that keg testing operators should be shielded/protected against the possible event of any breakaway components/fragments which may occur during the testing process.

5.5.7 It is recommended that proper personal protective equipment (PPE) be worn.

5.5.8 There are different types of pressure test procedures required to validate keg system performance:

5.5.8.1 Design pressure testing should be performed at the design stage, or any revision thereafter. This would include any change in materials or material supplier, material thickness or keg geometry which may alter container integrity or its performance. This testing may include pneumatic and hydraulic pressurization to failure. Pneumatic testing to burst failure can be extremely violent and dangerous.

5.5.8.2 Proof testing should be performed during production to ensure specifications agreed upon by the manufacturer and the brewer/buyer are maintained.

5.5.8.2.1 Proof test pressure to be a minimum of 1.5 times the Maximum Allowable Working Pressure.

5.5.8.2.2 Proof testing is recommended to be performed on all kegs. In the event of demonstrated statistical process control, a validated quality assurance program may allow for testing on a sampling basis at a mutually agreed frequency.

5.5.8.2.3 Regarding blow molded kegs, in line proof pressure testing is important to filter out occasional defective blown containers caused by inferior preforms and/or faulty blow mold parameter settings.

5.5.9 The following pressure conditions represent rigors of trade for single use keg performance:

5.5.9.1 Normal Service Conditions include the full cycle of usage including filling, distribution, dispensing, and storage (connecting/disconnecting) of kegs (full, partially full and empty) at refrigerated or ambient conditions. Handling throughout all use phases may include a level of abuse from contact with sharp edges and surfaces that will still require the single use keg system to perform safely. Normal Service Conditions does not include deliberate misuse such as subjecting the closed keg to fire.

5.5.9.2 Filling pressure is dependent upon the system process and may reach pressures of up to 51psig. It is recommended that brewers have a maintenance and calibration program for their filling system.

5.5.9.3 Normal Operating Pressure for a beer keg is the gauge pressure inside of a beer keg under normal usage. This includes a range of pressures as the keg is filled, stored, and dispensed. These pressures will vary with the type and style of beer and the environmental conditions to which the keg is subjected. Normal Operating Pressure should never exceed the Maximum Allowable Working Pressure.

5.5.9.4 Maximum Allowable Working Pressure, MAWP, (also referred to as the maximum safe working pressure or the maximum allowable operating pressure) is the maximum pressure at which a keg should be allowed to operate. It represents the maximum gauge pressure that could develop in a keg absent venting, or external cooling of the keg. This is the worst case condition for normal service. The Maximum Allowable Working Pressure must never exceed the Design Pressure. The standard U.S. industry practice for MAWP is 60 psig. U.S. refillable kegs are commonly marked with a warning that the container will rupture if pressurized above 60 psig.
While not filled to these pressures, over-pressurization can occur as a result of a number of factors such as freezing, improper transportation and storage, climate, altitude, continued fermentation or overfilling. Single use keg manufacturers should prominently mark kegs and communicate the maximum allowable working pressure limits of their single use keg system. This is especially important when a keg’s design pressure differs from industry expectations.

5.5.9.5 Design Pressure is the maximum gauge pressure a keg is designed to withstand before rupture.

5.5.9.6 Safety Margin is the amount by which the Design Pressure exceeds the Maximum Allowable Working Pressure. Safety margin is expressed as a multiplier. The safety margin multiplier is applied to satisfy keg durability for the rigors of trade. For single use rigors of trade the design pressure at minimum is recommended to be 2.5 times but less than 5 times the maximum allowable working pressure.

5.5.9.6.1 Exposure to UV light and moisture pick up tend to degrade the molecular structure and deteriorate plastic molded containers. These conditions may result in some plastic containers requiring a design pressure at the upper portion of the range above.

5.5.9.7 It is recommended that a pressure relief device be included in the keg design. The relief device should activate above the MAWP and must not exceed the design pressure.

5.5.9.8 In all cases the dispensing system should be equipped with a pressure regulator and a pressure relief valve(s) set below the MAWP.

5.5.9.9 Keg Proof Pressure is 1.5 MAWP at 72°F for 30 seconds. Kegs should withstand this pressure without permanent deformation. It is recommended that the manufacturer perform this pressure test on every keg.

5.5.9.10 The following table provides an overview interpreted from national standards and guidelines.

<table>
<thead>
<tr>
<th>Standard or Guideline Document</th>
<th>Maximum Allowable Working Pressure</th>
<th>Design Pressure (Range or Minimum)</th>
<th>Relief Pressure (Maximum)</th>
<th>Proof Pressure</th>
<th>Keg Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>BA Guideline Single Use</td>
<td>60 psig</td>
<td>2.5 X MAWP and &lt; 5 X MAWP</td>
<td>2/3 Design Pressure</td>
<td>1.5 X MAWP</td>
<td>Up to 60L</td>
</tr>
<tr>
<td>Germany DIN 6647-1 Refillable</td>
<td>3 bar (43.5 psig)</td>
<td>60 bar (870 psig)</td>
<td>45 bar (652 psig)</td>
<td>-</td>
<td>Up to 50L</td>
</tr>
<tr>
<td>Germany DIN 6647-4 Single Use</td>
<td>4 bar (58 psig)</td>
<td>1.5 X Pressure Relief Set Point</td>
<td>≤5 X MAWP</td>
<td>1.5 X MAWP</td>
<td>Up to 60L</td>
</tr>
<tr>
<td>Australia AS2971 Refillable</td>
<td>.5 MPa (72.5 psig)</td>
<td>2.2 MPa (319 psig)</td>
<td>Optional .5 MPa (72.5 psig)</td>
<td>.75 MPa (109 psig)</td>
<td>-</td>
</tr>
<tr>
<td>UK BFBi S. Steel Refillable</td>
<td>4.14 bar (60 psig)</td>
<td>75 bar (1102 psig)</td>
<td>Optional 40 +/- 5 barg Per DIN 6647-1</td>
<td>6.21 bar (90 psig)</td>
<td>100L</td>
</tr>
<tr>
<td>UK BFBi Plastic Single Use &amp; Refillable (pending)</td>
<td>4.14 bar (60 psig)</td>
<td>Manufacturer Defined</td>
<td>Manufacturer Defined to Fail Safe, Required for Refillable</td>
<td>6.21 bar (90 psig)</td>
<td>Up to 50L</td>
</tr>
</tbody>
</table>
5.5.9.11 The following temperature conditions represent rigors of trade for single use keg performance:

5.5.9.11.1 Refrigerated storage temperature range: 30°F to 48°F
5.5.9.11.2 Outdoor filled exposure temperature range: -20°F to 120°F (140°F in direct sunlight)

5.5.9.11.2.1 Direct exposure of single use kegs to sunlight and/or heat sources should be avoided whether full, partial empty or pressurized. Extreme heat conditions may cause single use kegs to deform and/or fail.

5.5.10 Recommended tests to verify keg system physical performance. Proper PPE and safety protocols should be established before commencing with any testing.

5.5.10.1 Distribution Performance Testing - ASTM D4169
5.5.10.2 Drop/Impact Testing - ASTM D5276-92, Test Method 001 for Single Use Kegs
5.5.10.3 Drop/Impact Testing - ASTM D2463, Bruceton Staircase Method
5.5.10.4 Horizontal Impact Testing - ASTM D4003-92 and ASTM D5277-92, Test Method 002 for Single Use Kegs
5.5.10.5 Pressure Testing - Design Pressure Test - Test Method 003
5.5.10.6 Pressure Testing - Proof Pressure Test - Test Method 004
5.5.10.7 Valve Leak Testing – Production QA testing before filling - Test Method 005
5.5.10.8 Compression Testing - ASTM D4577, ASTM D642
5.5.10.9 Shock Impact Testing - ASTM D880-92
5.5.10.10 Mechanical-Shock Fragility of Product - ASTM D3332-92
5.5.10.11 Rapid Pressure Determination - ASTM D3070-00
5.5.10.12 Standard Practice for Fluorescent Ultraviolet (UV) Exposure of Plastics – ASTM D5208-09 and ASTM D4329-05

5.5.11 It is recommended that prior to purchase of a single use keg system, that analytical and organoleptic testing be performed to determine if there are any objectionable changes in flavor, odor, or beer color influenced by the materials of construction of the keg components or filling and dispensing processes.

5.5.12 Comprehensive testing for product package interaction should involve all product contact surfaces of the keg components.

5.5.13 The purpose of compatibility testing is to understand the properties of the keg and beer by analyzing the interaction between them. This interaction could include migration of keg packaging materials such as polymers, additives, or metals into the beer. It could include permeation of substances from the environment through the keg packaging materials into the beer such as oxygen ingress or carbon dioxide egress. It could include absorption of a substance from the beer such as aromatic compounds into the keg packaging material. Testing measures the effects and interactions of different types of packaging, beer, and environmental conditions. Recommended tests to verify beverage and keg system compatibility:

5.5.13.1 Ferrous (Iron) pickup = < 20ppb Fe after 60 days with beer at 40-45°F


5.5.13.2 Volatile organic compound (VOC) pickup

5.5.13.2.2 Gas chromatography-mass spectrometry

5.5.13.3 Flavor Scalping
5.5.13.3.1 Gas chromatography-mass spectrometry

5.5.13.4 Oxygen transmission
5.5.13.4.1 F1927 Standard Test Method for Determination of Oxygen Gas Transmission Rate, Permeability and Permeance at Controlled Relative Humidity Through Barrier Materials Using a Coulometric Detector

5.5.13.5 CO₂ permeation
5.5.13.5.1 ASTM F1115 - Standard Test Method for Determining the Carbon Dioxide Loss of Beverage Containers
5.5.13.5.2 ASTM F2476 - Test Method for the Determination of Carbon Dioxide Gas Transmission Rate (Co 2TR) Through Barrier Materials Using An Infrared Detector

5.5.13.6 UV and visible light degradation
5.5.13.6.1 ASTM D5208-09 "Standard Practice for Fluorescent Ultraviolet (UV) Exposure of Photodegradable Plastics"
5.5.13.6.2 ASTM D5071-06 "Standard Practice for Exposure of Photodegradable Plastics in a Xenon Arc Apparatus"
5.5.13.6.3 ASTM D4329-05 "Standard Practice for Fluorescent UV Exposure of Plastics"

5.5.13.7 Organoleptic analysis (sensory panel)

5.5.13.8 Color concentration and change
5.5.13.8.2 Colorimeter (L*, a*, b*)

5.5.13.9 Oil lubricant residue
5.5.13.9.1 Camphor Oil test

5.5.13.10 Product flavor and freshness stability


5.5.13.10.3 Gas chromatography-mass spectrometry

5.5.13.11 Microbiological analysis
6. REGULATORY AND SAFETY

6.1 Regulatory

6.1.1 Refer to the Alcohol and Tobacco Tax and Trade Bureau website, TTB.gov/beer, for a complete listing of requirements regarding:

   6.1.1.1 Permits
   6.1.1.2 Regulations and Statutes
   6.1.1.3 Labeling
   6.1.1.4 Taxes

6.1.2 Regarding keg and keg component suppliers, the following is recommended at a minimum:

   6.1.2.1 Suppliers should comply with Current Good Manufacturing Practices (21CFR) and the applicable Food Safety requirements and all applicable state and local food laws and regulations.
   6.1.2.2 Suppliers should maintain total material traceability throughout their processes and maintain load integrity / security with documented load seals in accordance with the Public Health Security and Bioterrorism Act of 2002 and the Food Security Guidelines (March 2003).
   6.1.2.3 Suppliers should maintain and furnish upon request: documentation of all test methods, formulation of polymer components, documentation of manufacturing processes, as well as regulatory approvals of materials, and SDS sheets.
   6.1.2.4 Supplier should require a Certificate of Analysis document for all raw materials used.
   6.1.2.5 All packaging materials and components should comply with the limited heavy metal content, as detailed in US legislation Coalition of Northeastern Governors (CONEG) Heavy Metal regulations.
   6.1.2.6 Suppliers are encouraged to keep documented records of recycled content used in daily production.
   6.1.2.7 Plastic components of single use kegs should be marked by the manufacturer with the standard recycling symbols developed by the American Society of Plastics Industry. Month of manufacture or equivalent traceable code should be included.

6.2 Safety

6.2.1 It is recommended that all keg components, and equipment that interacts with single use keg assemblies, (such as kegs, spears, valves, taps, carbon dioxide tanks, nitrogen tanks, and filling equipment) be equipped with safety devices to mitigate risk of injury or damage to individuals and equipment. Altering, circumventing, or destroying safety features of any of these components are not recommended.

6.2.2 It is recommended that all systems to which a keg can be connected, whether commercial or "homemade" that use pressurized air, carbon dioxide, water, etc. should have a pressure regulator and properly sized pressure relief valve. These should be set, checked regularly, and maintained for relief at a pressure lower than the weakest component.
6.2.3 Pressure, temperature, volume, flow settings of the filling process equipment should be maintained according to those established and proven by the qualified OEM.

6.2.4 Under the OSH Act, employers are responsible for providing a safe and healthful workplace. Employers should comply with all applicable OSHA standards. Employers should also comply with the General Duty Clause of the OSH Act, which requires employers to keep their workplace free of serious recognized hazards.

7. KEG FILLING

7.1 Kegs should be filled per established industry methods with good manufacturing practices in a fail safe manner. It is recommended that keg compatibility be verified in partnership with the keg filling system vendor. Overall keg and beer quality should be maintained by working with the keg supplier and filling system vendor to provide the optimum filling sequence. Failure to do so may cause damage to the keg, damage to equipment, or injury.

7.2 Brewers should ensure the kegs have been pre-flushed with inert gas prior to filling.

7.3 Cleaning solutions, soap, line lubricant and related brewery process chemicals especially alkaline caustic based, may be incompatible with single use kegs. Avoid contact on conveyors surfaces or incidental surface rinse at even dilute solutions and check with keg manufacturer for specific recommendations.

7.4 It is important to establish the correct filling: volumes, temperatures, pressures, counter pressures, and velocities to achieve effective filling. A more detailed overview of keg filling can be found in the appendix.

7.4.1 Accurate metering or filling by weight system is important to avoid overfilling. An overfill condition creates a hydraulic pressure in the keg and can lead to dispensing problems if the hydraulic pressure of the beer is too high leading to foam or wild beer when the keg is first tapped. Overfill with limited headspace also renders the keg susceptible to damage from thermal hydraulic expansion, from freeze and/or heat, as well as pressure surge from drop impact (water hammer effect).

7.5 Brewers should comply with all federal, state, and local regulations on net weight/volume for label claim.

7.6 Proper keg head space should be established for each keg design based on label claim volume, the keg manufacturers direction, filling method, and beer type. Flood filling (overflowing container) during filling process is not recommended.

7.7 Overpressuring keg with carbon dioxide (CO₂) to increase CO₂ levels after filling process is never recommended.

7.8 Disengagement of the valve/spear assembly for filling is not recommended. Keg valve removal is for quality control inspection of the keg and valve only.

7.9 No objectionable odors should be near the filling location to protect beer quality.

7.10 Always check with the keg manufacturer and filler equipment vendor for clear instructions for filling the specific single use keg technology. While kegs can be filled in an upright or inverted position, some keg technologies require special filling considerations to assure safe function and avoid damage. A purpose built single use keg filling system is encouraged.

7.10.1 The process for filling a single use keg differs from a D-System refillable keg. D-System wash and fill process will generally sterilize, purge and pressurize the container prior to filling. This process is unnecessary for single use kegs which only require a pre-sanitizing of the container neck, opening of the valve, filling at a product supply pressure not exceeding 35 to 40 p (counter pressure during fill at 15 to 20 PSIG), closing the valve, scavenging the container neck of product and re-sanitizing the neck before release and a final application of a cap or seal.
8. **KEG & PLANT QUALITY CONTROL PROCEDURES**

8.1 The following is a recommended series of procedures that a quality manager might wish to use to verify correct keg equipment operation and to ensure that kegs are being filled within specification.

8.1.1 Microbiological checks of the keg:

8.1.1.1 Methods of doing this vary slightly. The main objective is to ensure sampling consistency is maintained, i.e. having introduced the sterile liquid into the keg, each keg should be rotated a set number of times to ensure all surfaces have been covered equally before it is extracted. A known quantity should always go into the keg and a known quantity should always be extracted, filtered and plated. This procedure should be carried out at a frequency that provides confidence on bio-reduction practices.

8.1.1.2 The following procedure demonstrates an approach to check for microbial integrity. This test may be appropriate for initial keg vendor qualification for the brewer and annual revalidation. Introduce a liter of sterile liquid, preferably beer, into an empty keg via a sterilized keg valve and "funnel" coupler. Rotate the keg three times to ensure all surfaces have been equally covered. Remove 500ml of the sterile liquid into a sterile flask. Split the sample into three 100ml samples via Millipore type membranes, plate and incubate the membranes on agar suitable for aerobic and anaerobic organisms. Sample collection, plating, and incubation can be performed by an independent laboratory, and as such the test could be conducted as a service of the keg manufacturer.

8.1.1.3 An alternate more routine check of microbial integrity would be to fill a test keg with beer using the brewery's normal procedure and then collect a sample for plating. This requires specific equipment to perform successfully without contamination, such as a sanitary welded stainless steel gooseneck Sankey style tap. Periodic samplings should be plated using normal quality procedures to analyze for aerobic and anaerobic organisms.

8.1.2 Beer microbiological stability sampling:
8.1.2.1 Samples are taken from the Bright Beer Tank and/or Serving Tank and keg at a frequency directed by the brewery quality department. A suitable stability test is to set aside a keg of beer from the keg line after filling and "forcing" the contents by leaving the keg in an environment of 70°F (21°C). Taste, odor and clarity tests can then be taken after 72 hours and at regular duration as desired to satisfy quality control standards.

8.1.3 Keg pressure sampling:

8.1.3.1 A keg filled with beer should be removed from the keg line and allowed to stand for 5 to 10 minutes. A "pressure test" coupler is connected to the keg. Pressure in the keg should be approximately 75% of the counter pressure used during the latter part of the filling sequence.

8.1.3.2 The residual pressure in the keg after filling will indicate that the keg CO₂/N₂ in solution is going to be maintained. If the pressure in the keg is above that of the filling counter pressure, then it is highly probable that the keg was overfilled and creating a hydraulic pressure within the keg. When filling kegs upright or in the inverted position against a "back-up" probe, this hydraulic pressure condition will be common.
9. **STORAGE, HANDLING, AND TRANSPORTATION**

9.1 **General**

9.1.1 Performance testing should be completed by manufacturers to ensure the keg assembly maintains stability during warehouse and transport conditions, including for full good palletized loads as prescribed under ISTA 3E, for partial pallets, and for single units according to the brewers expected distribution channel. Temperature, humidity and shock and vibration need to be assessed for the specific container, and acceptance criteria established from manufacturer tests clearly communicated for the brewer. Refer to 5.5.10 testing section and appendix for suggested procedures.

9.2 **Storage**

9.2.1 Prior to usage, it is recommended that kegs be stored in accordance with commercially accepted practices and regulations.

9.2.2 It is recommended that brewers utilize a FIFO (first in first out) program for kegs.

9.2.3 Some single use kegs incorporate an active oxygen scavenging technology. It is important to work with the keg supplier to understand storage conditions and duration on the impact of empty and filled keg shelf life. Humidity and temperature can both influence shelf life performance.

9.2.4 No objectionable odors should be allowed in the keg storage areas or keg transport vehicle.

9.2.5 It is recommended that the keg storage facility be clean and free of dust/debris and have an insect and pest prevention system.

9.3 **Handling and Transportation**

9.3.1 Any packaging materials used during the transport or storage of empty kegs for delivery, including pallets, dunnage, etc. should not adversely affect the desirable physical properties of the keg system or the brewer’s product. Special attention should be given to pallet decking for nails, fasteners, screws, broken deck boards, or debris etc. which could damage the keg.

9.3.2 It is recommended that brewers review performance testing data to ensure the keg and spear assembly withstands supply chain distribution safely and without damage. There should be no sign of leak, bulging, cracking or other fatigue indicative of diminished performance or onset of failure. Refer to testing section for recommended testing procedures.

9.3.3 It is recommended that brewers review data from testing and validation of keg stability for typical handling and drops from route trucks. Refer to testing section for recommended testing procedures.

9.3.4 It is recommended that brewers establish protocols and procedures with their distributor for distributing kegs in an agreed manner. For example, drop cushions may be used during unloading to help avoid keg damage.
10. DISPENSING

10.1 Keg assemblies should be capable of being maintained fail safe in all events. Inspect keg and valve for physical defects or damage before attaching to dispense equipment.

10.2 It is recommended that retailers verify maximum dispensing pressures. These should be clearly marked/identified on the keg. Direct contact to the manufacturer should be made if this is not provided.

10.3 Be cautioned utilizing picnic pumps that do not have pressure relief system. Pressures can exceed 45 psig from this manual pump.

10.4 It is recommended that retailers make sure all regulators and pressure relieve valves are maintained and calibrated regularly per manufacturer’s directions.

10.5 It is recommended that retailers make sure all carbon dioxide and/or nitrogen gas tanks are maintained and located according to local municipality requirements.

11. KEG DECOMMISSIONING

11.1 It is recommended that retailers or distributors utilize qualified recycle/reclaim providers for proper disposal of single use kegs.

11.2 Single use keg and valve systems should be designed and so constructed that after emptying the internal pressure will be safely relieved and/or vented to atmospheric pressure. Precaution is required to assure venting operation is done in a safe manner with sufficient ventilation to avoid carbon dioxide build-up and risk of asphyxiatiion.

11.3 Single use kegs should never be disposed in a pressurized state. Manufacturers of single use kegs should provide clear instructions regarding de-pressurization, disposal and recycling of single use kegs. Retailer should follow keg manufacturer’s instructions on how to prepare the empty/expired kegs for safe disposal.

11.4 Single use kegs should never be reused. Beer contact components and the pressure containing vessel do not satisfy the rigors of trade for multiple use.
12. Glossary

12.1 **Beer**: The term beer means beer, ale, porter, stout, and other similar fermented beverages (including sake or similar products) of any name or description containing one-half of 1 percent or more of alcohol by volume, brewed or produced from malt, wholly or in part, or from any substitute thereof.

12.2 **Brewer**: Any entity which brews beer for sale.

12.3 **Burst Disc/Pressure Relief Disc**: A single use, non-reclosing, pressure relief device which opens at a predetermined differential pressure to relieve pressure. It is used as a safety device to allow a controlled release of pressure at or below the design pressure of the keg to prevent an uncontrolled rupture of the keg. Incorporated into the keg, the opening of the burst disc causes the keg to become scrap.

12.4 **Chimb or Chime**: The projecting edge or rim of a keg or cask.

12.5 **Coupler**: A connector valve separate from and compatible with a keg valve for controlling the introduction of gas into a keg and the release of beer out of a keg during dispense.

12.6 **D-System**: One of several versions of keg coupler styles available. The D-System is the common industry standard in N. America. The D-System is often referred to as Sankey D.

12.7 **Design Pressure**: The maximum gauge pressure a keg is designed to withstand before rupture.

12.8 **Design Pressure Testing**: Testing conducted at the design stage or any design revision for the purpose of validating the keg design pressure. Design revision includes any change in materials or material supplier, material thickness or keg geometry which may alter container integrity or its ability to satisfy the rigors of trade.

12.9 **Direct Fill**: Filling a single use keg as received from the manufacturer without a water rinse or wash process.

12.10 **Flavor Scalping**: Term used to describe the loss of quality of a packaged beverage due to either its volatile flavors being absorbed by the packaging or the beverage absorbing undesirable flavors from its packaging.

12.11 **Keg**: For the purposes of this document will be known as a small container/barrel constructed of stainless steel, aluminum, plastic or a combination of those materials. Wooden kegs are not addressed in this guideline.

12.12 **Maximum Allowable Working Pressure (MAWP) (also referred to as the maximum safe working pressure or the maximum allowable operating pressure)**: The maximum pressure at which a keg should be allowed to operate. It represents the maximum gauge pressure that could develop in a keg absent venting, or external cooling of the keg. This is the worst case condition for normal service. The Maximum Allowable Working Pressure must never exceed the Design Pressure. The standard industry practice for MAWP is 60 psig. U.S. single use kegs are commonly marked with a warning that the container will rupture if pressurized above 60 psig.

12.13 **Nitrogenize (sometimes referred to as nitrogenate)**: To infuse nitrogen gas into beer.

12.14 **Normal Operating Pressure**: Normal Operating Pressure for a beer keg is the gauge pressure inside of a beer keg under normal usage. This includes a range of pressures as the keg is washed, filled stored, dispensed and returned. These pressures will vary with the type and style of beer and the environmental conditions to which the keg is subjected. Normal Operating Pressure should never exceed the Maximum Allowable Working Pressure.

12.15 **Normal Service Conditions**: Normal Service Conditions include the full cycle of usage including emptying, washing, filling, distribution, dispensing, return and storage of (full, partially full and empty) at (refrigerated or ambient conditions). Normal service conditions include the Rigors of Trade. It does not include deliberate abuse such as subjecting the closed keg to fire.

12.16 **Pre-flush**: The act of sweeping the keg interior with an inert gas, typically carbon dioxide, in order to exclude oxygen from the headspace.

12.17 **Pre-pressurize**: The act of pressurizing the keg with a gas to test valve seal integrity and to provide single use keg structural integrity for empty transport.
12.18 **Pressure Relief Set Point:** The nominal pressure at which a relief valve, burst disc, or container itself controllably actuates and relieves pressure. The actual opening pressure will be within a specified tolerance.

12.19 **Pressure Relief Valve:** Reclosing pressure relief device to provide instant response to an increase in pressure at a predetermined differential pressure. Relief valves are set below the design pressure of the pressurized item and sized to prevent the pressurized item being over pressured. The pressure at maximum discharge rate should not exceed 110 percent of the maximum allowable working pressure.

12.20 **Proof Pressure Testing:** Pressure testing of each keg at manufacturing to verify pressure carrying capacity.

12.21 **PSIG:** Pounds per square inch, gauge. A measure of gas pressure against the atmospheric pressure, typically seen on gas regulator gauges. Since atmospheric pressure varies with altitude, the gauge pressure must be adjusted with altitude.

12.22 **Ra (roughness average) value:** Ra is a measure of the surface profile. Ra is typically expressed in micro-meters or micro-inches.

12.23 **Refillable Keg:** Kegs designed for multiple returns for washing, filling, warehousing and distribution.

12.24 **Regulator:** A gas control valve that delivers a set gas pressure regardless of tank pressure. There may be a primary regulator on the gas source and a secondary regulator at the gas connection for each keg.

12.25 **Rigors of Trade:** For single use kegs, the rigors of trade include empty storage under variable temperature and humidity conditions, shock and vibration of transport when empty and full, manual and mechanical handling including drops and impacts during moves and storage, pressurization and dispense, depressurization and additional handling.

12.26 **Safety Margin:** Safety Margin is the amount by which the Design Pressure exceeds the Maximum Allowable Working Pressure. For single use kegs, the design pressure is recommended to be within a range: a minimum of 2.5 times the Maximum Allowable Working Pressure up to a maximum of 5 times the Maximum Allowable Working Pressure.

12.27 **Sanitary Welding:** The process of joining material by welding where the finished product contact surfaces can be consistently cleaned to meet the requirements of food grade products.

12.28 **Single Use Keg:** A keg that is designed to be filled once and is not returned for refill.

12.29 **Spear:** An extractor tube that extends from the keg valve to bottom of the keg body.

12.30 **Tap:** The connector from the draught system to the keg, more commonly referred to as the coupler.

12.31 **Valve:** A self-closing valve that is opened by a coupler when the keg is cleaned, filled, or tapped. It has one or two valves that control liquid and gas flow in and out of the keg.

12.32 **Vendor:** A person or supplier company that provides equipment or packaging components for sale.
13. SOURCES


13.6 Alcohol and Tobacco Tax and Trade Bureau (TTB), U.S. Department of the Treasury. http://www.TTB.gov/beer

13.7 Brewing, Food, & Beverage Industry (BFBI), Standards for the Design /Manufacture/Performance /Purchasing of Keg Beer Containers http://www.bfbi.org.uk


13.9 American Society of Mechanical Engineers (ASME) http://www.asme.org

13.10 Deutsches Institut fur Normung (DIN) 6647-1, 6647-2, 6647-4 http://www.din.de


13.12 International Safe Transit Association (ISTA) http://www.ista.org

13.13 Coalition of Northeastern Governors (CONEG) http://coneg.org


13.18 ASBC – Methods of Analysis http://www.asbcnet.org

13.19 Nickel Development Institute (NiDI), Cleaning and Descaling Stainless Steels (9001) http://www.nickelinstitute.org

14. APPENDIX

14.3. Test Method 003 Design Pressure Test Method ........................................................................ 24
14.5. Test Method 005 Valve Leak Test Method for Single Use Kegs ................................................. 26
14.6. Filling System Detailed Description .......................................................................................... 27

Scope: The purpose of this document is to provide guidance on drop/impact testing on pressurized beer kegs. This guide is for kegs 15L to 60L. *This test method does not address all of the safety concerns. It is the responsibility of the user of this method to establish appropriate safety practices.*

Purpose: Determine if the keg is fit for use.

Material Components Required for Testing:
1. Test Kegs and corresponding components
2. Water
3. Thermometer
4. Valve
5. Measuring Device (i.e. tape measure and ruler/caliper)
6. Pressure Gauge
7. Lifting / Tilting apparatus (i.e. a sling)
8. Dropping Surface: 1 inch thick steel plate on concrete

Procedure:

Test 1: Top of keg body on hand hole drop
1. Fill keg completely with 40°F water and 15 psig at least 99.5% full
2. Lift filled keg to a height of 4 feet (1.2 meters)
3. Tilt keg to an angle of (45°/50°)
4. Utilizing a release mechanism, drop keg onto steel plate on the top of keg body on hand hole

Passing criteria for Test 1:
No bursting and no leakage, and functionality of the container for safe handling and dispensing remain unaffected.

Test 2: Perpendicular to hand hole drop
1. Fill keg completely with 40°F water and 15 psig at least 99.5% full
2. Lift filled keg to a height of 4 feet (1.2 meters)
3. Tilt keg to an angle of (45°/50°)
4. Utilizing a release mechanism, drop keg onto steel plate at a location perpendicular to hand hole

Passing criteria for Test 2:
No bursting and no leakage, and functionality of the container for safe handling and dispensing remain unaffected.

Test 3: Bottom keg body/butt weld drop
1. Fill keg completely with 40°F water and 15 psig at least 99.5% full
2. Lift filled keg to a height of 4 feet (1.2 meters)
3. Tilt keg to an angle of (45°/50°)
4. Utilizing a release mechanism, drop keg onto steel plate at a location perpendicular to hand hole

Passing criteria for Test 3:
No bursting and no leakage, and functionality of the container for safe handling and dispensing remain unaffected.

Summary: Summarize the test results and finalize the report.
14.2. Test Method 002 Keg Horizontal Drop/Impact Test Method for Single Use Kegs

Scope: The purpose of this document is to provide guidance on drop/impact testing on pressurized beer kegs.
(This guide is for kegs 15L to 60L. This test method does not address all of the safety concerns. It is the responsibility of the user of this method to establish appropriate safety practices.)

Purpose: Determine if the keg is fit for use.

Material Components Required for Testing:
1. Test Keg and corresponding components
2. Water
3. Thermometer
4. Valve
5. Measuring Device (i.e. tape measure and ruler/caliper)
6. Pressure Gauge
7. Lifting / Tilting apparatus (i.e. a sling)
8. Dropping Surface: 1 inch thick steel plate on concrete

Procedure:

Test: Horizontal Keg body Impact Drop
1. Fill keg completely with 40°F water and 15PSI at least 99.5% full
2. Lift filled keg to a height of 4 feet (1.2 meters)
3. Tilt keg to an angle of 90° from floor
4. Utilizing a release mechanism, drop keg onto steel plate on keg side

Passing criteria for Test:
No bursting and no leakage, and functionality of the container for safe handling and dispensing remain unaffected.

Summary: Summarize the test results and finalize the report.
14.3. Test Method 003 Design Pressure Test Method

Scope: The purpose of this document is to provide guidance on pressure performance of new keg designs or modifications of a keg design including process changes, material changes and sourcing.

(This test method does not address all of the safety concerns. It is the responsibility of the user of this method to establish appropriate safety practices.)

Purpose: To verify that the keg design can withstand the design pressure and fail safely upon rupture with no fragmentation.

Material Components Required:
1. Test Kegs and corresponding components without a pressure relief device
2. Test Kegs and corresponding components with a pressure relief device
3. Water
4. Thermometer
5. Valve
6. Hydraulic Pump
7. Measuring Device (i.e. tape measure and ruler/caliper)
8. Pressure Gauge
9. Timing Device (i.e. clock, stop watch, etc.)

Procedure:
1. Heat soak fill water and keg to a standard test temperature of 68°F (20°C).
2. Fill keg completely with water.
3. Allow the water to come up to the ambient temperature of the test cell.
4. Fit valve and connect hydraulic pump
5. Measure keg diameter in three places along keg wall at predetermined distances marked on the keg.
6. Measure overall height of keg from base to top of coupler.
7. Apply pressure to keg using hydraulic pump and bring to 30 psig.
8. Measure deflection at 30 seconds, 3 minutes, 5 minutes, 1 hour, 3 hours, 8 hours, 24 hours, 3.5 days
9. Monitor results and determine if further testing is required.
10. Increase the pressure to 60 psig and measure at the same time intervals as listed in point six above.
11. After 7 days at 60 psig, increase the pressure to 90 psig. Hold for 28 hours.
12. Increase pressure gradually until keg ruptures or safety relief device actuates.
13. Select a new keg and repeat test at 104°F (40°C)
14. Record date, time, temperature and rupture pressure
15. Analyze test results
16. Finalize test report

Passing criteria for Test:
Kegs must be capable of withstanding the design pressure for 28 hours without evidence of permanent deformation and fail safely with no fragmentation at rupture or vent pressure.

Summary: Summarize the test results and finalize the report.
14.4. Test Method 004 Proof Pressure Test Method for Single Use Kegs

Scope: The purpose of this document is to provide guidance on proof pressure testing of kegs and testing of keg resistance to permanent deformation due to pressurization. 
(This test method does not address all of the safety concerns associated with this test. It is the responsibility of the user of this method to establish appropriate safety practices.)

Purpose: Determine if the keg is fit for use regarding pressure resistance.

Material Components Required for Testing:
1. Complete manufactured keg
2. Valve or quick connect
3. Pneumatic Pump
4. Clean, oil free plant air
5. Measuring Device (i.e. tape measure, ruler/caliper, go/no go gauge)
6. Pressure Gauge
7. Timing Device (i.e. clock or stop watch)

Procedure:
1. Measure keg diameter in three places along keg wall at predetermined distances.
2. Measure overall height of keg from base to top of neck.
3. Apply pressure to keg using pneumatic pump and bring to 1.5 x MAWP and hold for 30 seconds.
4. Relieve the pressure.
5. Re-measure keg diameters and heights.
6. Record data.
7. Analyze test results
8. Finalize test report

Passing criteria for Test:
Kegs must be capable of withstanding a minimum internal pressure of 1.5 X MAWP without leaking or deformation.

Summary: Summarize the test results and finalize the report.
14.5. Test Method 005 Valve Leak Test Method for Single Use Kegs

**Scope:** Production testing of keg valves for leakage. This test is not meant to be proof of design for new or redesigned valves.

(This test method does not address all of the safety concerns associated with this test. It is the responsibility of the user of this method to establish appropriate safety practices.)

**Purpose:** Determine if the valve is fit for service.

**Material Components Required for Testing:**
1. Complete manufactured valve
2. Keg or test fixture to simulate keg
3. Pneumatic Pump
4. Clean, oil free plant air
5. Pressure Gauge
6. Timing Device (i.e. clock or stop watch)

**Procedure:**
1. Apply pressure to valve using pneumatic pump and bring to 20 psig and hold for 30 seconds.
2. Relieve the pressure.
3. Record data.
4. Analyze test results
5. Finalize test report

**Passing criteria for Test:**
Valves must be capable of withstanding a minimum internal pressure of 20 psig without leakage or failure.

**Summary:** Summarize the test results and finalize the report.
14.6. Filling System Detailed Description

A typical preparation and filling sequence for a valved single use keg is described below. Always check with the manufacturer for clear instructions for filling the specific single use keg technology.

STERILIZATION — The keg neck and filler connection head are sterilized prior to opening the keg valve.

GAS PURGING — The keg is purged with gas to displace oxygen from the headspace. This can be CO₂, N₂ or a mixture of both.

GAS PRESSURIZATION — The keg is pressurized with gas to a counter pressurization level that is dependent upon the method and rate of filling used, the beer temperature, and the volume and type of gas or gases in solution in the beer.

FILLING — Filling of the keg is achieved with a beer "overfill" monitoring system which can be combined with a metering system or a "fill by weight" system at the filling head.

GAS and/or WATER SCAVENGING — After filling, the keg valve is closed and the residual beer in the connection head of the machine is disposed to drain or a beer recovery system. The keg valve and neck are in some instances rinsed with sanitizing water prior to being released from the head.

Special attention to filling techniques, with a view to faster but quieter filling, greater fill accuracy and less product loss is a necessity. Automatic keg packaging lines include a beer boost pump (a pump between the beer buffer tank and the filler) fitted with a Variable Frequency Drive (VFD) to vary the pump output to match the varying demand of a multi-filling head keg line. Small automatic and semi-automatic keg lines will generally suffice with a "flat curve" constant speed pump to achieve the same near constant pressure requirement for good filling conditions.

All automatic and semi-automatic machines are fitted with a sensor in the outlet pipe work of the filling head to stop the flow of beer when detected by the sensor. This indicates that the keg has filled correctly or there is a leakage detected across the keg valve and the filling systems connection head.

Other methods of fill monitoring are generally added (in addition to the outlet sensor) to the filler to comply with "fill" regulatory requirements and product economy. All kegs are slightly oversized so as to afford headspace expansion in the keg.

FILLING BY METER:

Beer fill metering used on single valve keg lines falls into four categories; Turbine, Volumetric, Magnetic Flow and Mass Flow metering.

TURBINE — Turbine meters have a rotor mounted between two bearings. As beer flows past this rotor it rotates. An induction sensor head mounted on the outer wall of the turbine housing senses the rotor blades rotating and produces a series of pulses. When the pulses reach a preset value, the beer valve on the filler and the keg valve are closed. Turbine meters are accurate to within 60ml. (2.0oz.) but can be susceptible to bearing damage during cleaning and sterilizing regimes.

VOLUMETRIC — The volumetric meter operates on a similar principle but instead of a turbine rotor it uses a rotary piston with three or four accurate volume chambers which have a typical accuracy of ± 100ml. (3.0 oz.). The volumetric meter is also susceptible to damage during cleaning and sterilizing regimes.

MAGNETIC — Magnetic flow meters do not suffer similar damage during cleaning and sterilizing since they have no moving parts and measurement is based on induction. Electronics enable high frequency coil excitation and the monitoring of variable flow conditions with improved accuracy and repeatability. Magnetic flow meters are consistently accurate to within 50ml. (1.6oz.).

MASS — The mass flow meter has all the advantages of the magnetic flow meter in so far as there are no moving parts in the flow stream. The mass flow meter measures changes in momentum related to the mass flow rate and has excellent fill repeatability and accuracy, but is rarely adopted due to a relatively high cost when compared to the other versions aforementioned.
FILLING BY WEIGHT:
Volumetric filling methods do not meet "fill" regulatory requirements. Therefore, brewers are required to measure the "fill" by weight. This in itself can be difficult when mixed populations of kegs of varying tare weights are used and the weighing takes place after the filling process.
To address this problem long term development has produced a series of semi-automatic and fully automatic filling machines that use the "Gravfill" system to tare weigh the keg immediately prior to filling and fill the keg by weight to within 0.02% repeatability.

QUIET FILLING:
Another filling technique is "Quiet" or "Black" filling, where the keg is counter-pressurized to a pressure slightly below the beer supply pressure. As filling commences the gas pressure in the keg is slowly decreased until the desired differential pressure is reached. Although using more gas and taking longer to fill, the technique overcomes problems associated with filling nitrogenized beer.
Improved keg valve design and filling techniques have overcome many of the problems faced when filling a keg, with:
1. Beers at up to 10ºC (50ºF).
2. Nitrogenized beers.
3. High and low carbonated beers using the same filling profile, and;
4. Keeping product losses to a minimum.