PROCESS SAFETY MANAGEMENT SERIES

Prepared by the DISCUS Safety & Risk Management Committee

DISTILLED SPIRITS COUNCIL
OF THE UNITED STATES

Process Safety Management Series
Introduction

What is it?
Process Safety is a disciplined framework for managing the integrity of operating systems and processes and handling hazardous substances by applying good design principles, engineering, operating practices, and a change management structure.

Why Is It Important?
It deals with the prevention and control of incidents that have the potential to release hazardous materials or energy. Such incidents can cause toxic effects, fire, or explosion and could ultimately result in serious injuries, property damage, lost production, and environmental impact.

Process Safety is About

- Identifying and understanding potential hazards
- Evaluating consequences, safeguards, and risks
- Adding layers of protection (safeguards) to prevent and/or mitigage incidents
- Protecting employees, the public, the environment and assets through these safeguards
- Communicating potential risks and mitigation efforts to communities in which we operate as appropriate

About This Guide

This series explores different process safety topics with short papers created by the Distilled Spirits Council of the United States' (DISCUS) Safety & Risk Management Committee, and in particular the Committee's Process Safety Management Working Group, to educate the industry on this important topic and showcase best practices that distillers can incorporate into their facility safety procedures.

The DISCUS Safety & Risk Management Committee is charged with evaluating and proactively engaging applicable regulatory agencies, insurance companies and other standards making organizations to ensure that the fire protection and risk management standards and guidelines affecting the distilled spirits industry are appropriate. The Committee evaluates new technologies and develops and shares non-proprietary technical data, procedures, and other relevant information with DISCUS member companies consistent with the antitrust laws and with the fire protection and risk management community.

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The first guidance document in our Process Safety Management series addresses Pressure and Vacuum Relief Valves in Pot Still Distillation.

PROCESS SAFETY MANAGEMENT SERIES

Pressure and Vacuum Relief in Pot Still Distillation

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Pressure and Vacuum Relief in Pot Still Distillation

Purpose

The purpose of this document is to inform distillery owners and operators about the importance of proper pressure and vacuum relief for pot stills and provide information and considerations related to effective pressure relief management. Pressure relief may be applicable any time you have a possible energy source, internal or external, in a closed vessel.

The purpose of this guide is to focus on the pressure-related risks of pot distillation. This is not meant to be a comprehensive guide, other areas of pressure relief must be taken into consideration when engaging in distillery operations. There are also other risks associated with pot stills, such as fire, burn, and electrical risks. For fire-related issues, please refer to the DISCUS Recommended Fire Protection Practices for Distilled Spirits Beverage Facilities Manual, which can be found here.

Introduction to Pressure Relief Valves

The primary function of Safety Relief Valves is the **protection** of life, property, and environment. A Safety Relief Valve is a (safety) device designed to protect a vessel or system against over-pressure should all other safety systems fail.

An overpressure event refers to any condition which would cause pressure in a vessel or system to increase beyond the specified design pressure or maximum allowable working pressure (MAWP).

A Pressure Relief Valve must be capable of operating at all times, especially during a period of power failure when system controls are nonfunctional.

Pressure relief valves should not serve any other process related function—their only function is safety.

Pressure Relief Background

There are several reasons why the pressure in a vessel or equipment can exceed a predetermined limit. The most common are:

- Blocked outlet
- Exposure to external fire
- Thermal expansion of fluid
- Abnormal process conditions (i.e., chemical reaction)
- Cooling system failure
- Heat exchanger tube rupture
- Pipework component failure
- Control Valve failure

Each of the above listed events may occur individually or simultaneously. Every cause of over-pressure will create a different mass or volume flow to be discharged. It is the process engineer's responsibility to determine the worst case scenario for the sizing and selection of a suitable pressure safety device. Collaboration between the still manufacturer, the design engineer, and the owner/operator is necessary to properly select and design appropriate pressure relief mechanisms. In a typical distillation setup, blocked outlets and/or external fires are the most likely "worst case" scenarios and should certainly be considered in the sizing of the pressure relief device (more details below).

Pressure and Vacuum Relief in Pot Still Distillation

Once a condition occurs that causes the pressure in a system or vessel to increase to a dangerous level, the pressure relief valve may be the only device remaining to prevent a serious failure, such as rupture of the still and release of hot, explosive, and/or environmentally damaging liquid or gasses. Since reliability is directly related to the complexity of the device, it is important that the design of the pressure relief valve be as simple as possible.

Pressure and Vacuum Relief in Pot Still Distillation

The pressure relief valve must open at a predetermined set pressure (less than the maximum allowable working pressure or design pressure), flow at rated capacity at a specified overpressure, and close when the system pressure has returned to a safe level. The specified overpressure should be determined by an engineer based on your specific installation, taking into account the worst-case scenario.

Pressure relief valves must be designed with materials compatible with many process fluids, from simple air and water to the most corrosive media. They must also be designed to operate in a consistently smooth and stable manner on a variety of fluids and fluid phases.

A pressure safety valve is a safety device and, in many cases, the last line of defense against catastrophic failure. Catastrophic failure is a failure which is both sudden and causes termination of one or more fundamental functions.[1]

It is important to ensure that the pressure safety valve is capable of operating at all times and under all circumstances, independent of operator actions, power failures, and other situations. A safety valve is not a process valve or pressure regulator and should not be misused as such.

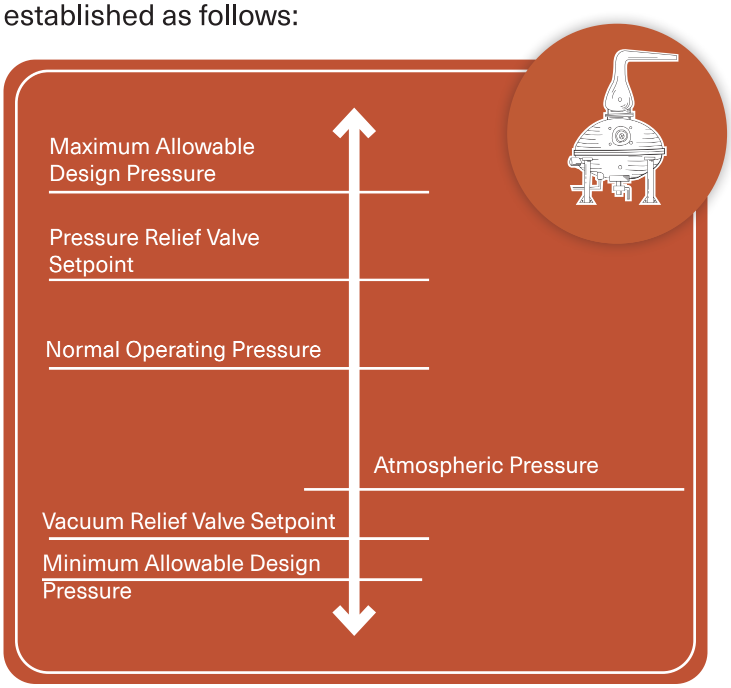
Pressure relief valves should be operated for one purpose only: protection.

An under pressure situation can also lead to a serious failure of a vessel. Examples of situations that can potentially lead to an under pressure situation are:

- Emptying vessel
- Blocked inlet
- Sudden contraction of vapors due to rapid cooling

Because these conditions can occur in many distillation setups, most stills require both pressure and vacuum relief. *See Appendix A for diagram examples of pressure and vacuum relief pot stills.*

Relative setpoints and design conditions should be established as follows:



[1] **American Institute of Chemical Engineers, Process Safety Glossary.** https://www.aiche.org/ccps/resources/glossary/process-safety-glossary/catastrophic-failure

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Valve Types

There are multiple types of safety and pressure relief valves available for different types of applications. The type recommended for still setups would be a Safety Relief Valve.

A Safety Relief Valve is a type of pressure relief valve that may be used either for liquid or compressible fluid and is characterized (1) by rapid opening or pop action, or (2) by opening in proportion to the increase in pressure over the opening pressure, depending on the application. This type of valve should not be confused with common "relief valves," which are pressure relief devices actuated by inlet static pressure having a gradual lift, generally proportional to the increase in pressure over opening pressure. This type of valve is primarily used for liquid service and would not be applicable on a still. Relief valves are generally meant to protect equipment, whereas safety valves aim to protect people, the surrounding environment, and processes

This guidance is related to safety relief valves, specifically the low-lift and full lift:

LOW-LIFT SAFETY VALVE

A low-lift safety valve is a safety valve in which the disc lifts automatically such that the actual discharge area is determined by the position of the disc.

FULL-LIFT SAFETY VALVE

A full-lift safety valve is a safety valve in which the disc lifts automatically such that the actual discharge area is not determined by the position of the disc.

The full-lift type is typical for pot still operations.

Codes, Standards and Recommended Practices

Many Codes and Standards are published throughout the world which address the design and application of pressure relief valves. The most widely used and recognized of these is the ASME Boiler and Pressure Vessel Code, commonly called the ASME Code.

Many Codes and Standards are voluntary, which means that they are available for use by manufacturers and users and may be written into purchasing and construction specifications. The ASME Code is unique in the United States and Canada, having been adopted by the majority of state and provincial legislatures and mandated by law.

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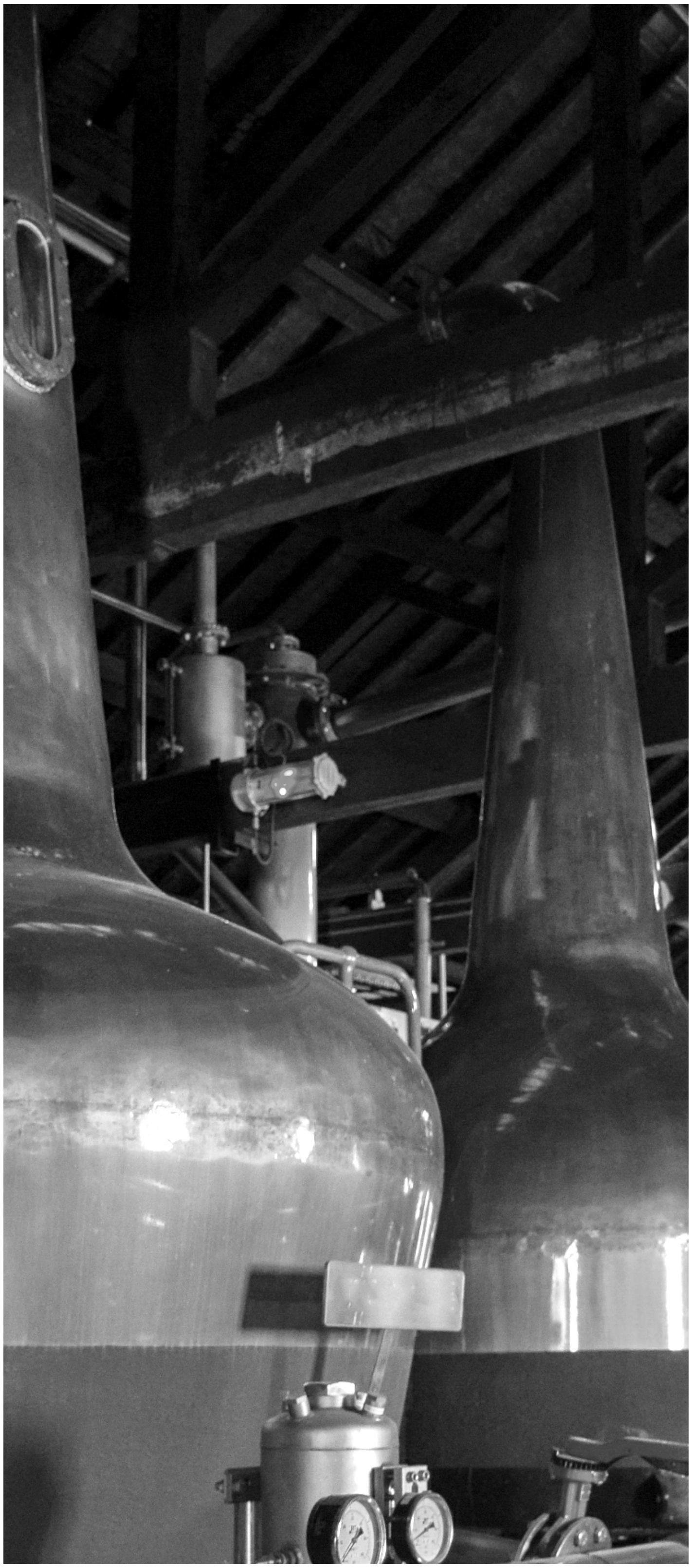
It is a common misunderstanding among distillers that because stills are typically operated at or near atmospheric pressure, that the ASME Boiler and Pressure Vessel Code is not applicable to still operations. While it is true that not every portion of this Code is applicable to stills, the hazard presented by over pressure conditions in stills is such that pressure relief is absolutely required to protect both people and property, and the ASME Code is the best source for design and application guidance.

Pressure and Vacuum Relief in Pot Still Distillation

Pressure Relief Valve Design and Selection Guidance

The goal of this guide is to help you understand your equipment or the equipment you are hoping to acquire. This is a foundation for building safe processes and equipment. **"The worksheet included in Appendix B will** will walk through key items to consider. When completing this worksheet, you should consider each element of your process individually. For example, if your distillation process consists of a column still, condenser, pot still, pot still condenser, and storage tank, you should consider each item individually. This will help better select appropriate safety controls for your process and equipment.

Equipment, much like your process, has defined limits of what it can handle. When handling things like high pressures, high heats, and steam, understanding the capabilities of your equipment allows you to make decisions on how to mitigate risk. As part of the pre-start up safety review, anything related to pressure relief devices should be checked. Any time equipment is changed, additional reviews of pressure relief devices should be conducted.



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Understanding Risk

A "what if" evaluation is a simple tool that allows you to review the process risks involved in your process. This list is built based off of serious incidents that have happened at other distilleries in the past. It should be completed individually for each vessel being reviewed. This review should take place during the design phase of a distillery but should also be redone periodically to incorporate any changes to the operations.

1. What if the temperature is too high?
2. What if the liquid level is too low?
3. What if the liquid level is too high?
4. What if the pressure is too high?
5. What if the flow is too high?

Understanding your Controls

Controls are what mitigate the risk that you may experience in your processes. Understanding your controls helps you identify your gaps and address them.

Pressure Relief:

1. What is the size of the pressure relief valve?
2. Where is the relief valve located?
3. What is the maintenance frequency of the valve?
4. What is the pressure rating of the valve?

Additional Considerations

1. List all design pressures and setpoints in the same units (i.e., psi) to make sure you are comparing accurately. Be aware of the difference between psig (gauge pressure) and psia (actual pressure).
2. The distillate outlet does not constitute pressure or vacuum relief.
3. If there are no trays or any internal impediments in the still (gin baskets or similar) between the liquid and the condenser, a single point of pressure/vacuum relief is acceptable. However, if there are trays or gin baskets, ensure that pressure relief is installed between any possible energy source (such as steam, external fire, etc.) and the impediment.
4. Commonly appropriate setpoints are +15% of the design setpoint for pressure relief and -5% for vacuum (i.e., for an atmospheric still pressure relief at 1.15 atm and vacuum at 0.95), but this should be confirmed with your still manufacturer.
5. Pressure relief should be installed close to the still but vented to a safe area with no impediments (i.e., no valves, minimal bends).

A safe area in this instance typically would be outside of the building in a non-populated area that is safe to receive alcoholic vapors and has the appropriately rated equipment to not create additional risk to property and lives.

Thinking through the answers to each of these questions can help you identify which risks are most in need of mitigation. This could be a risk that is not likely but would be catastrophic or highly dangerous if it were to occur, or it could be a risk that might be less hazardous but is more probable given the operating conditions. Both of these types of risks may warrant mitigations such as pressure relief, alarms, automatic shutoffs, etc.

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6. Typically, a flame arrestor is also utilized on still pressure relief setups, due to the potentially flammable nature of the vapors.

7. There must be no impediment on vacuum relief (for example, make sure there's a screen for birds and squirrels).

8. At a minimum, an inspection of the setup should be conducted annually, or more often, depending on manufacturer recommendations and installation conditions.

9. Water type and disc type pressure relief are both commonly used in distillery setups but note that, if you select a water type pressure relief setup, regular inspection of the water levels is required to ensure they are functioning correctly.

10. Ensure that all connections have a higher pressure rating than the relief valve itself.

ALL STILLS SHOULD HAVE INDEPENDENT PRESSURE RELIEF

For questions about this guidance document, please contact safety@distilledspirits.org

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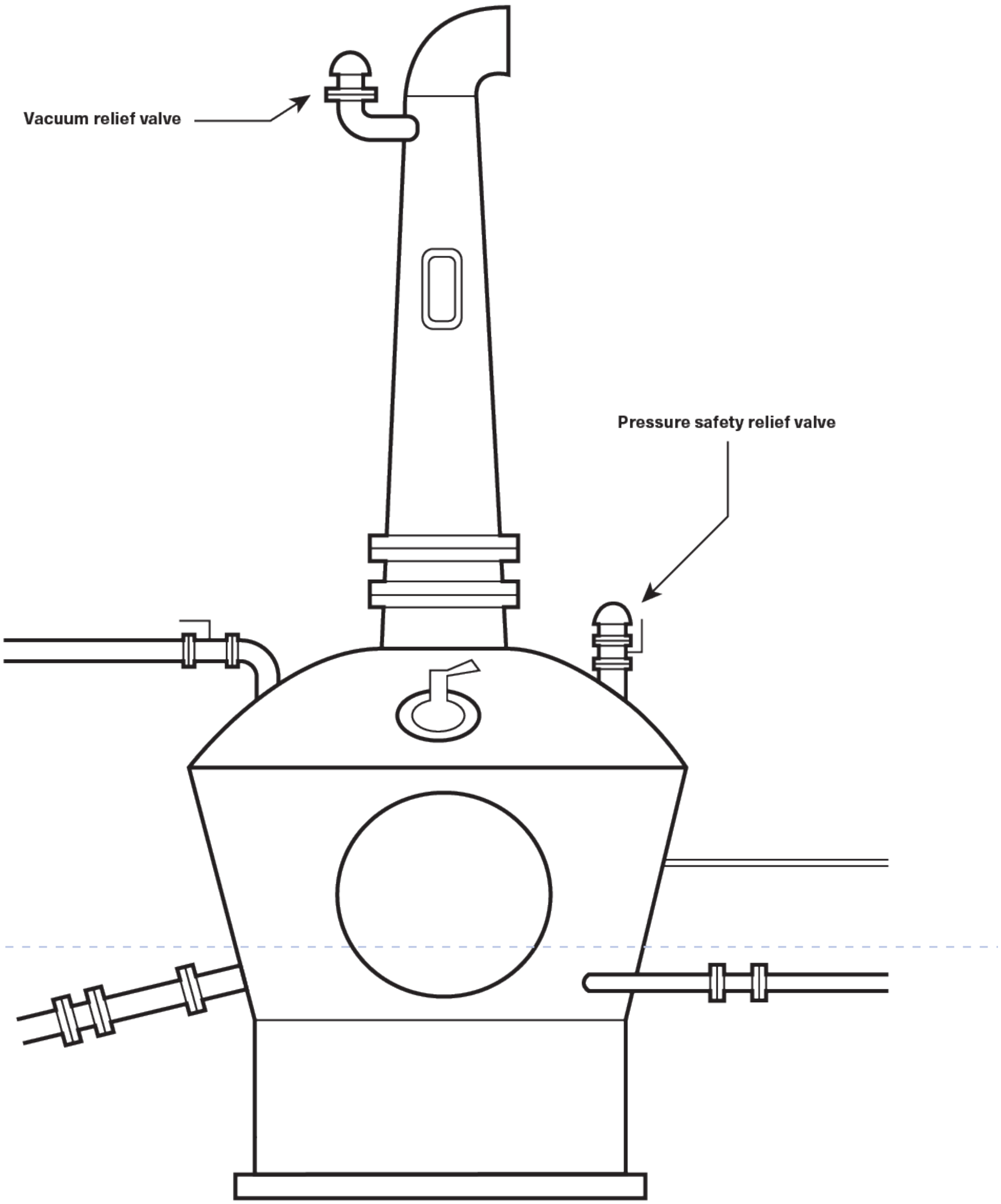
Pressure and Vacuum Relief in Pot Still Distillation

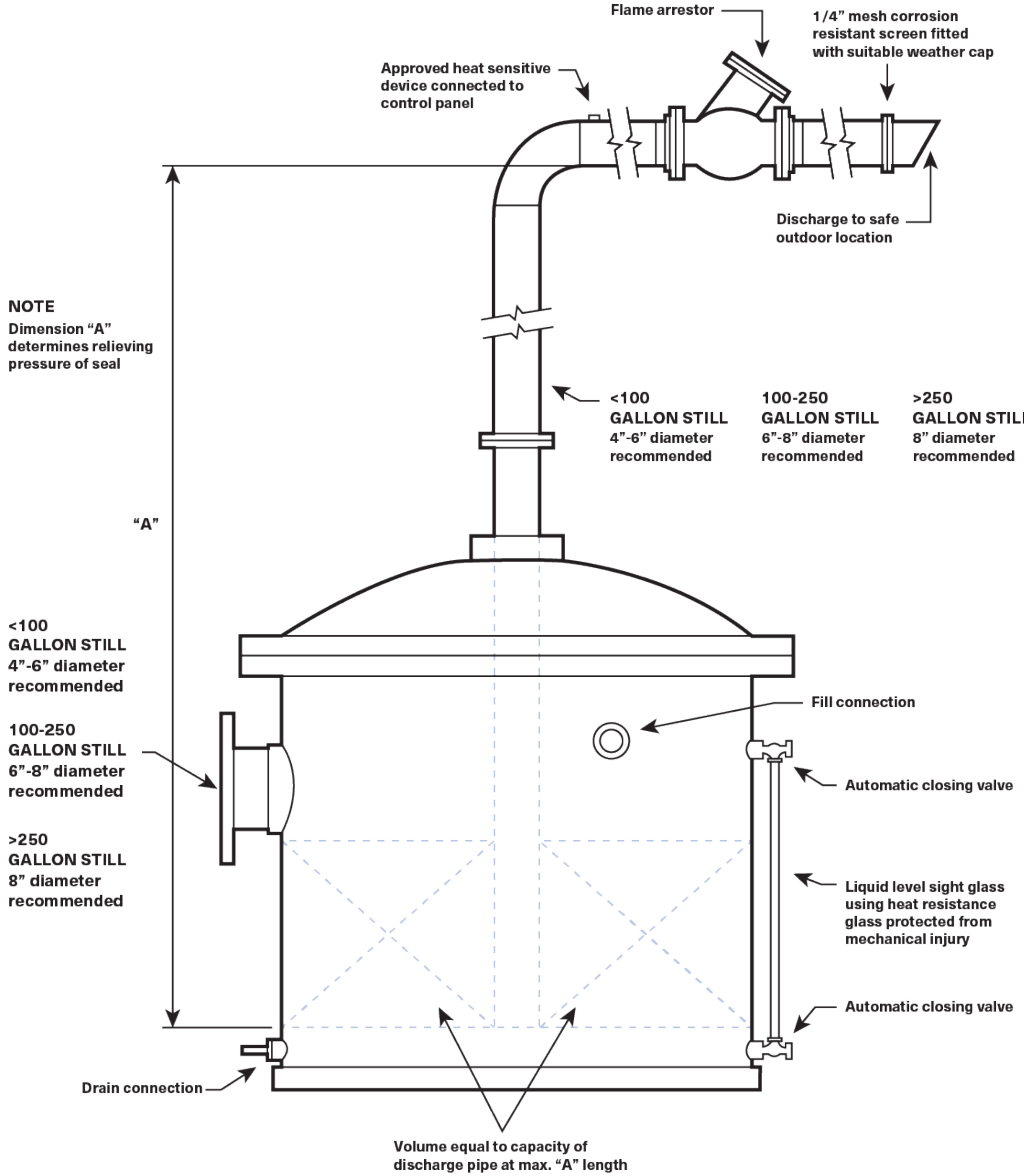
Appendix A



Example of a Whiskey Making Pot Still

Pressure and Vacuum Relief in Pot Still Distillation

Appendix A



Example of a Pressure/Vacuum-Relieving Seal Pot

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Appendix B

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Worksheet: Understanding Your Equipment

Number	Data	Response	Comment
1	Maximum Operating Temperature this piece of equipment should experience		
2	Maximum Normal Operating Pressure		
3	Equipment Make		
4	Equipment Model		
5	Material of Construction		
6	Is the vessel pressure rated?		
7	What is the vessel's pressure rating?		
8	If the vessel is not rated, what is the maximum operating pressure or maximum design pressure, per the manufacturer's specification?		
9	How is the vessel heated? (coil or flame directly under the vessel) or indirect, (steam from boiler is applied)?		
10	If indirect, how is heat transferred (vessel jacketed, steam pumped directly into vessel, etc.)		
11	Maximum operating capacity (gallons)		
12	Actual capacity (gallons)		
13	Maximum processing rate (gallons proccesed/minute)		