

1 Seal Chamber Configurations

Defining the Seal Chamber Design

Purpose: These plans define the **seal chamber design** and its interaction with the process fluid, influencing fluid circulation, heat dissipation, and contamination control through chamber geometry and internal flow paths. **E.g. API Plan 01, 02, 03.**

Applications:

- Used when the process fluid allows natural circulation for cooling and lubrication (**e.g., clean & non-clogging media**).
- Common in single seals where process conditions are stable, predictable, and no contamination risk.

Technical Considerations:

- Fluid circulation depends on chamber design—natural flow (**Plan 01**) or stagnant (**Plan 02**), affecting lubrication and heat transfer.
- Heat dissipation is passive, relying on chamber geometry and pump casing. **Plan 03** improves heat dissipation with increased fluid volume. **External cooling/heating jackets** may be needed for extreme conditions.
- Risk of heat buildup in stagnant chambers (**Plan 02**) can impact seal life if not managed properly

Expert Insight: Seal Chamber Design Plans use natural fluid dynamics but require careful management of **heat and contamination** risks. For fluids prone to **coking** or **vaporization**, support plans are essential for seal reliability.

2 Flush Plans

Maintaining Seal Chamber Conditions

Purpose: Flush plans introduce a continuous flow of **fluid to the seal chamber** to remove heat, prevent solids accumulation, maintain lubrication, control vaporization, and ensure stable operating conditions. **E.g. API Plan 11, 12, 13, 14, 21, 22, 23, 31, 32, 41.**

Applications:

- **Non-hazardous** process fluids where minor leakage to the atmosphere is acceptable.
- Pharmaceutical, food, and specialty chemical applications, where **process fluid contamination** risks must be minimized.

Technical Considerations:

- **API 682** specifies that the flush flow rate should be calculated based on pump differential pressure and system requirements.
- **Orifice sizing** and **pressure drops** should be carefully designed to prevent excessive flow, which could lead to higher power consumption.
- If an external flush is used (**e.g., Plan 32**), its fluid compatibility, temperature, and contamination risks must be evaluated to avoid seal face wear.

Expert Insight: Improperly designed flush plans can accelerate **seal face wear** instead of preventing it. Always assess the solids content, temperature profile, and fluid compatibility **before selecting** a flush plan to ensure effective cooling and contamination control.

3 Buffer Plans

Ensuring Zero Process Contamination

Purpose: Buffer Plans use a **low-pressure** buffer fluid in dual-seal systems to prevent process contamination by allowing **controlled leakage** of process fluid into the buffer fluid, while also aiding in heat dissipation. **E.g. API Plan 52, 55, 72.**

Applications:

- Common in **non-hazardous** process fluids where a small amount of leakage can be safely managed.
- Applied in services where contamination of the process fluid must be minimized (**e.g., Pharmaceuticals & Food Processing**).

Technical Considerations:

- **API 682** specifies that buffer fluid pressure shall be lower than process pressure to allow controlled leakage into the buffer fluid. Buffer fluid pressure shall not exceed **2.8 bar (40 psi)** in **Plan 52 & 55** and **0.7 bar (10 psi)** in **Plan 72**.
- Vent and drain arrangements should be designed to prevent buffer fluid buildup and cross-contamination.
- Buffer fluids should have low vapor pressure to **prevent flashing** inside the seal chamber.

Expert Insight: Proper **selection** of buffer fluid—ensuring low vapor pressure, adequate lubricity, and thermal stability—is key to seal reliability. **Cooling** requirements need careful consideration for handling high-temperature or volatile processes.

4 Barrier Plans

Ensuring Zero Process Leakage

Purpose: Barrier Plans use a **pressurized** barrier fluid in a dual-seal system to ensure **zero process leakage** to the atmosphere. The higher pressure of the barrier fluid prevents process fluid from leaking to the atmosphere. **E.g. API Plan 53A, 53B, 53C, 54, 74.**

Applications:

- Used in industries where **zero leakage** is mandatory, such as chemicals, pharmaceuticals, and hazardous fluids handling.
- Preferred for seals in toxic, flammable, or environmentally sensitive processes to ensure **absolute containment**.

Technical Considerations:

- **API 682** specifies that Barrier Fluid Pressure shall be at least **1.4 bar (20 psi)** higher than process pressure for **Plans 53A, 53B, 53C, and 54**, and at least **1.7 bar (25 psi)** higher for **Plan 74**, ensuring zero process leakage to the atmosphere.
- Barrier fluid pressure should be actively regulated to ensure consistent sealing and system reliability.
- Barrier fluid should have **low volatility, high thermal stability, and good lubricity** to support seal longevity.

Expert Insight: Barrier Plans provide the highest level of leakage control for **safety-critical applications**. Choosing the right barrier fluid and maintaining correct pressure are **key factors** in ensuring seal reliability and compliance with environmental regulations.

5 Quench Plans

Preventing External Contamination & Solid Buildup

Purpose: Quench Plans use an external fluid (**steam, gas, or liquid**) on the **atmospheric side** of the seal to prevent icing, manage coking, dilute leakage, and improve seal longevity in challenging conditions.

E.g. API Plan 51, 62.

Applications:

- Flushes leakage and prevents accumulation in **single seals** where process fluid can crystallize, polymerize, or coke upon leakage.
- Common in high-temperature, slurry, or cryogenic applications to prevent **seal face damage**.

Technical Considerations:

- Quench flow should be **controlled** to prevent overcooling and pressure fluctuations at the seal face.
- Selected quench fluid should **match** process conditions (e.g., steam for high temperatures, nitrogen for cryogenics, and water for cooling).
- Proper drain design and sizing are critical to avoid fluid buildup or contamination. The drain outlet port **should be larger** than the quench inlet port.

Expert Insight: Quench Plans are essential for seals exposed to harsh atmospheric conditions, preventing solid buildup, thermal shock, and premature wear. **Proper quench medium** selection and controlled flow ensure stable operation and extended seal life.

6 Collection Plans

Controlling & Monitoring Leakage

Purpose: Collection Plans **capture and control** seal leakage to prevent unsafe emissions, workplace hazards, and environmental contamination, ensuring compliance and safe disposal. **E.g. API Plan 65A, 65B, 66A, 66B, 75, 76.**

Applications:

- Used in single and dual seals where leakage must be **collected** instead of released, especially in hazardous or volatile processes.
- Common in industries requiring **leakage monitoring** for maintenance planning and regulatory compliance.

Technical Considerations:

- Collection systems should be properly vented to prevent pressure buildup and designed with **sufficient capacity** to handle expected leakage without overflow.
- For hazardous fluids, level (liquid) and pressure (gas) monitoring with **alarm features** detect excessive leakage at an early stage.
- Integrating leakage detection systems enables **continuous monitoring** of fluid levels and identification of abnormal seal conditions.

Expert Insight: Collection Plans manage leakage by venting gases and draining liquid while preventing emissions. Proper **venting** avoids backpressure, and **drainage** prevents fluid buildup. Leakage monitoring ensures timely intervention, reducing seal failure risks.