

# Seal Quality Test Method Examples

## - Residual Seal Force

- RSF Slides courtesy of Roger Asselta, Genesis Packaging Technologies

## Seal Quality Tests

- Tests used to **characterize and monitor** the **quality and consistency** of a **seal parameter** providing some assurance of the package's ability to remain integral
- **Parameters monitored** may include
  - Seal quality or characteristic
  - Package materials
  - Package components
  - Sealing process
- **SQT are not leak tests**

## Seal Quality Tests

- **Passing SQT  $\neq$  leak-free package**
- Examples
  - Heat seal strength**
    - A pouch with a strong heat seal peel force may have a pinhole in the pouch face
  - Closure application force**
    - A well-closed capped bottle may leak due to a scratch on the bottle finish

## Seal Quality Tests

- **Failing SQT = package integrity risk**
- Examples
  - Heat seal strength**
    - A pouch with a weak heat seal peel force is more likely to leak during product life cycle
  - Closure application force**
    - A loosely capped bottle may leak during shipping
- **SQT and package leak tests work together to ensure package quality**

## Seal Quality Tests

- Tests included
  - Closure application and removal force
  - Package burst
  - Package seal strength
  - Residual seal force \*
  - Airborne ultrasound
  - Vision inspection (including x-ray)

\* J. Ludwig, et al, *J Parenteral Sci & Technol*, 47, 5, 1993, p. 211, and 49, 5, 1995, p. 253

# Residual Seal Force

Roger Asselta,  
Vice President and Senior Advisor



Genesis Packaging Technologies

# Residual Seal Force (RSF)

- RSF is the Stress A Compressed Elastomeric Closure Flange Continues to Exert on A Vial Land Sealing Surface after Application of an Aluminum Seal (Crimping).
- USP <1207.3> Seal Quality Test
- Quantifying the RSF is a Test Method for the Indirect Estimation of Elastomeric Closure Compression.
- Sufficient Compression is Essential to Seal Integrity.

# RSF Test Method Concept

- There is an Optimum Window of Closure Compression
  - Too Little versus Too Much Force
- Poor Compression Cannot be Visually Detected
  - RSF Testing is an Indirect Measure of Compression
- RSF testing is recognized in the recently revised USP <1207> Sterile Product Packaging – Integrity Evaluation in section <1207.3> Package Seal Quality Test Methods



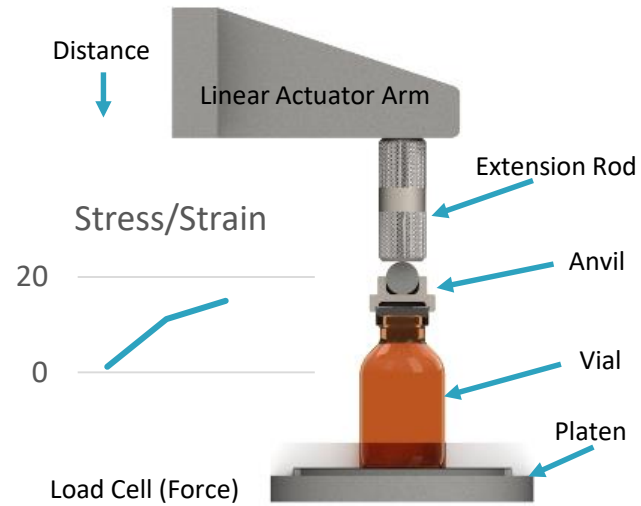
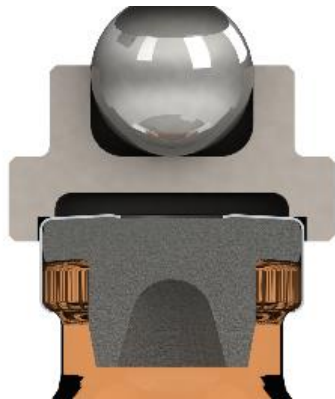
# Basis of RSF Testing

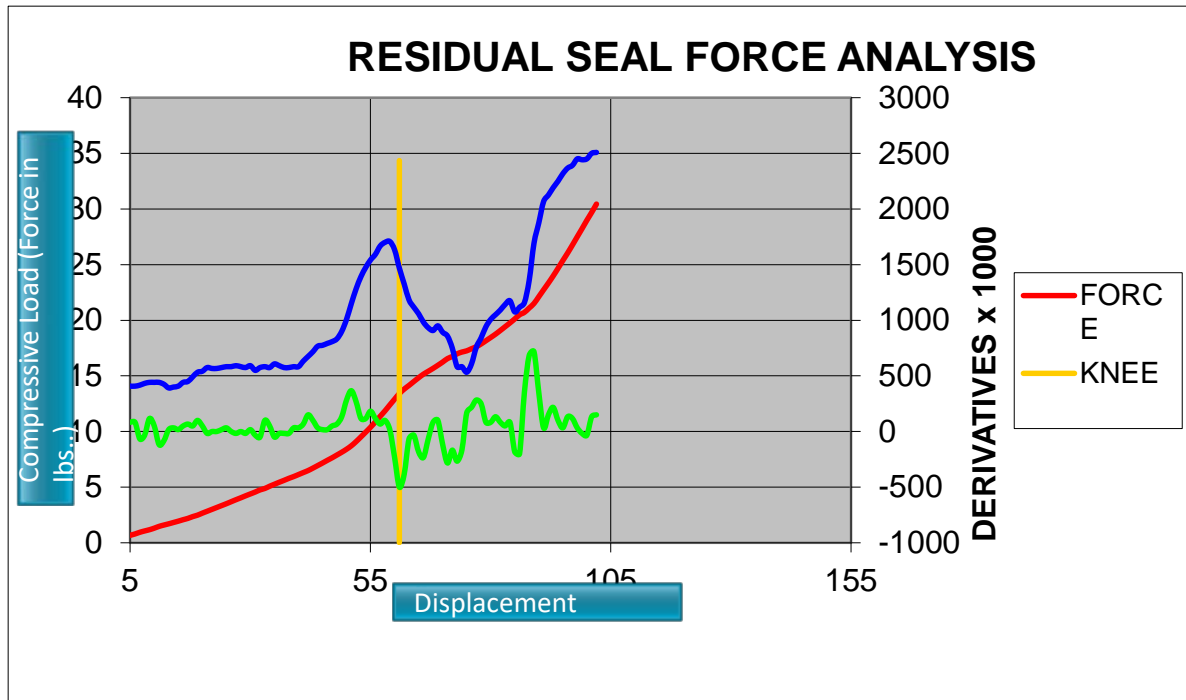
- Upon Capping the Closure Flange is Compressed Against the Vial Land Sealing Surface
- The Closure Acts Like a “Compressed Spring”
- The Tester Exerts Force on the Cap/Stopper
- When the Tester Force Exceeds the Closure Compression Force, Graphically the Stress-Strain Slope (Rate of Change) Drops
- This “Knee” in the Curve Equals the RSF
- $>\text{Applied Force at Capping} > \text{Closure Compression} > \text{RSF}$

# RSF Testers



# RSF Tester



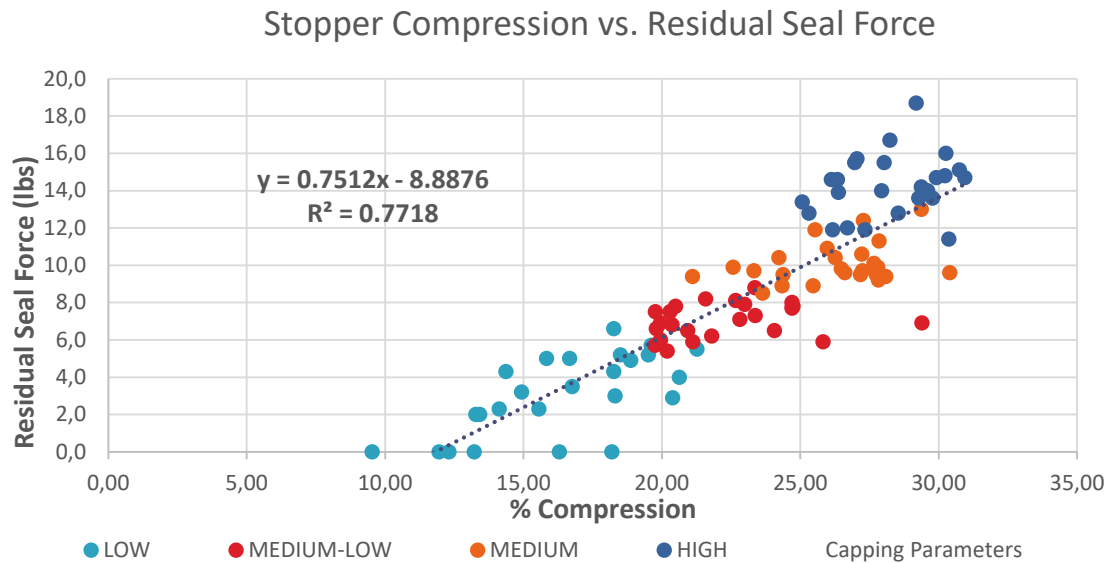


The compression curve (red) is a combination of the viscous and elastic responses to the stress from tester load. “The knee”(yellow) is where additional deformation occurs. An algorithm is applied, using the 1<sup>st</sup> (blue) and 2<sup>nd</sup> (green) derivatives to accurately identify that knee.

# Significance and Use of RSF Test Method

- Package Development
  - Determine Effects of CCS Component Variables
    - Dimensional Tolerances, Durometer, Cure, Processing etc.
    - Assembled CCS Processing, Distribution, Storage
- Validation
  - *Establish Optimum Capping Parameters*
  - Evaluate Variation
- Production
  - Verify Capping Equipment Set-Up
  - Capping Process Monitor

# Correlation of RSF to Compression



Example: 20mm Serum Soft Stopper

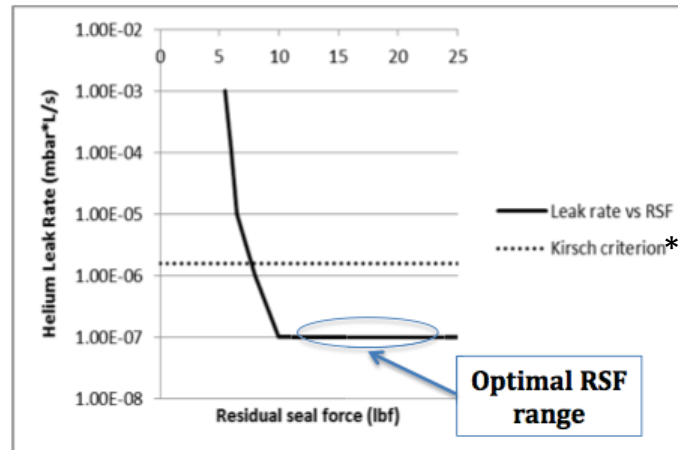
# Correlation of RSF to Leak Rate

## Tracer gas leakage rate (ASTM F2391) vs Residual seal force

Optimal RSF resulted in consistent leak rates well below the rate predicted for a 0.2 $\mu$ m hole

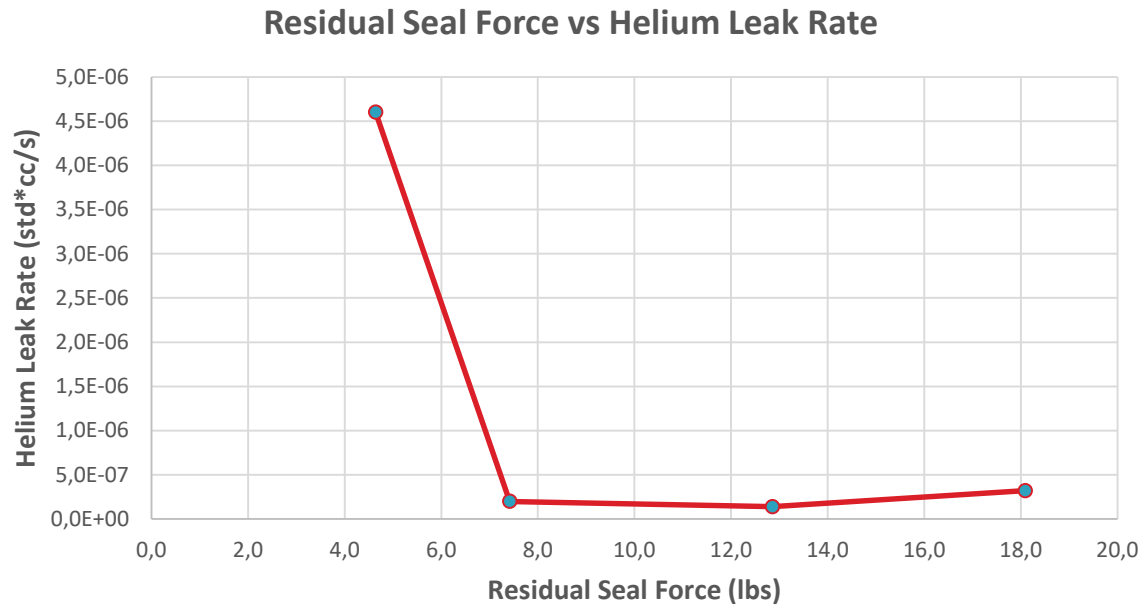
Ref. L Kirsch, L Nguyen, C Moeckly, R Gerth, *Pharmaceutical container/closure integrity II: The relationship between microbial ingress and helium leak rates in rubber-stoppered glass vials*, PDA J Pharm Sci & Tech 51, 1997, 195 - 202

\* Microbial ingress is a probability function.  
Critical leakage rate of log 5.8 or about 0.2-0.3 $\mu$



Illustrative purpose only. Courtesy of Dana Guazzo, PhD RxPax

# Residual Seal Force vs Helium Leak Rate

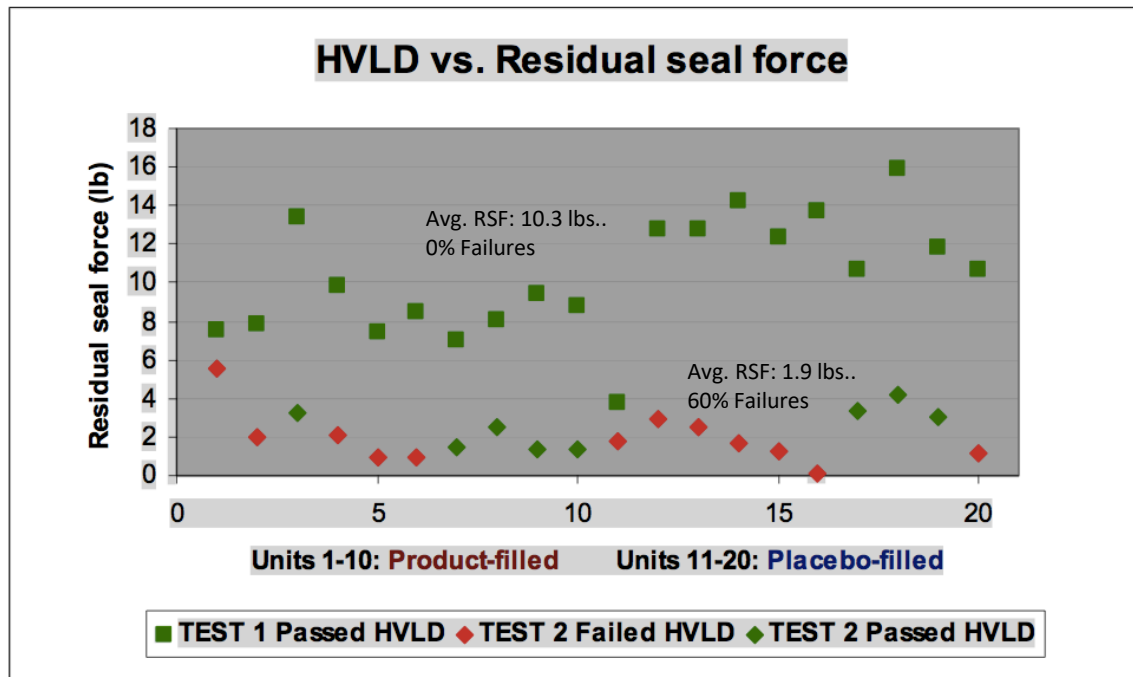




# HV Leak Detection / RSF



# Leakage Failures, High vs. Low RSF



# Using RSF Testing

”RSF values may be used in effectively setting up vial cappers and for monitoring the crimping process. With an understanding of compression and leak rate cut-off, RSF can be further used as a predictor of leakage risk.”

S. Orosz and D Guazzo, “Leak Detection and Product Risk Assessment’ presented at PDA Meeting, Mar 2010, Orlando, FL

# Using RSF Testing

“The RSF tester can be used to characterize the resulting residual seal force of a capped vial independent of the capping equipment used, which can facilitate the comparison of seal quality of DP units manufactured in different facilities. In addition, a suitable RSF range that would still show full CCI, is recommended specific for each CCS combination and can be established using different capping equipment.”

Mathaes, R.; Mahler, H.; Roggo, Y.; et al. Influence of Different Container Closure Systems and Capping Process Parameters on Product Quality and Container Closure Integrity in GMP Drug Product Manufacturing, *PDA J Pharm Sci & Technol* 70, (2016) 109-119