



New Snubber Program Owner Training Seminar

Disclaimer

The information contained herein represents the experience and opinions of the presenters. It does not represent an official position or recommendation of the SNUber Users Group (SNUG) and is intended for informational use.

Information pertaining to ASME codes or regulatory positions is presented for historical purposes and any use or interpretations should be verified through those organizations utilizing their approved processes.

Speaker Introductions

Steve Norman

Steve Norman

- 12 Years with Fluor-Daniel at Farley
 - Piping / Instrument Engineer in construction
 - Maintenance Engineer in production
- 19 Years with Southern Nuclear at Farley
 - Maintenance Specialist
- Snubber Program Owner at Farley for 21 years
- Current Chair of OM Subcommittee ISTD
- Current Chair of QME Subcommittee QDR
- Current member of ASME Standards Committees for both Section XI (ISI) & OM (IST) as well as current Chair of Standards Committee QME (Qualification)
- Current Member of ASME Board of Nuclear Codes and Standards (BNCS)
- 2 ½ Years as Welding Engineer at Fort Calhoun
- 1 ½ Years as Pressure Test Coordinator at Palo Verde
- Previously with Altran Solutions
- Previously with Sargent & Lundy
- Currently employed by Enercon Services, Inc., assigned to Vogtle 3 & 4 as IST & Snubber Programs Engineer

General Info



We will be going through material quickly



Questions are welcome, but in the interest of time, some may be deferred to conference Question & Answer times if time is not available during or after seminar

Purpose of Seminar

- Industry Personnel Turnover Results In
 - Lack of Program Continuity and Consistency
 - Loss of Knowledge and History
 - Loss of "Big Picture" as Focus Shifts to Implementing Established Tasks
- SNUG Board of Directors Approved Seminar(s) to Address These and Other Issues

History of SNUG

- First Meeting December 6, 1984
 - St. Petersburg, Florida
 - 26 Attendees
 - Generic Issue 113
- Incorporated in 1998
- Annual Winter Working Conference from 1984 until 2020
- Annual Summer Conference & Trade Show from 1985 (held virtually in 2020 & 2021)
- Annual Business Meeting at Summer Conference since 1999

Past Issues

- Generic Issue 113 (NUREG/CR-5416)
- Generic Letter 90-09 Input
- Addressed Information Notices, Bulletins, etc.
 - IN 89-30
 - IN 94-48
- Input to LCO 3.0.8 development

SNUG Documents Available

- White Papers
- Working Group Reports
- Letters
- Other Documents

White Papers

- Alternate Visual Examinations
- End Attachment Gaps
- Vibration and Fretting Corrosion
- Drag Testing of Mechanical Snubbers
- Beyond Design Basis Events

Disclaimer with each White Paper:

THIS DOCUMENT HAS BEEN DEVELOPED BY THE SNUBBER USERS GROUP (SNUG) FOR USE BY ITS MEMBERSHIP. THIS INFORMATION IS REPRESENTATIVE OF THE GENERAL CONSENSUS OF THE SNUG, BUT MAY NOT REPRESENT THE OPINIONS OF ALL OF THE SNUG MEMBERSHIP. NO PART OF THIS DOCUMENT SHOULD BE CONSIDERED AS MANDATORY POLICY THAT MUST BE ADHERED TO BY ANY SNUG MEMBER.

Other Documents

- Lubrication Working Group Report
- Program Document Template
- Program Assessment Guide (workshop provided on use of guide)
- Letter to NRC Reply to IN 94-48

Manuals

- Seal Life Manual
- Hydraulic Snubber Manual
- Mechanical Snubber Manual

Seminar Objectives

- Focus on 'Big Picture'
 - Primarily Addresses Generic Program Scope and Basis Issues
 - Snubber Specific Technical Issues to be Addressed in More Specific Seminars
- Provide History of Program Requirements
 - Evolution of Requirements
 - Basis of Original Requirements
- Provide Overview of Current Program Requirements
 - Outline Current Requirements
 - Governing Documents / Licensing Basis for Current Requirements
 - Compare / Contrast Various Basis Requirements
 - Interaction of Codes & Regulations

History of Snubber Program Requirements

- Plants built in the 1960's and early 1970's had no testing, examination or service life monitoring requirements for snubbers.
- Snubber supports were treated the same as variable spring supports or constant load supports.
- Snubber supports were included in the ISI program along with all other types of supports.
- Most snubber populations were primarily hydraulic at that time and most hydraulics had external tubing.
- Snubbers began exhibiting problems associated with hydraulic fluid leaks, mostly occurring at tubing fittings or with lexan reservoirs cracking.

History of Snubber Program Requirements

- First NRC requirements issued early to mid 1970's
 - Developed because of experiences with snubbers in service
 - Hydraulic snubber seals
 - Failure to lock-up
 - IEB 73-03: Defective Hydraulic Shock Suppressors and Restraints
 - IEB 73-04: Defective Bergen-Paterson Hydraulic Shock Absorbers
 - IEB 75-05: Operability of Category I Hydraulic Shock and Sway Suppressors
 - IEB 78-10: Bergen-Paterson Hydraulic Shock Suppressor Accumulator Spring Coils

History of Snubber Program Requirements (Cont.)

- Early Technical Specifications
 - NUREG-371 Recommendations
 - Development of Technical Specification
 - Standard Review Plan (SRP) Revision
 - Regulatory Guides
 - 1980 - Revision to Standard Tech Specs 3/4.7.9 (Snubbers)
 - 1981 – Revision to SRP 3.9.3

History of Snubber Examination & Testing Requirements (Cont.)

- Early Technical Specifications
 - Initial Tech Specs applied only to hydraulics
 - Included both visual examination and functional test requirements
 - 100% visuals at least once every 18 months
 - » As often as every month depending upon number of failures
 - » Every month if seal material is not proven
 - Testing applied to 50 Kip and smaller
 - » Lock-up, bleed, and FOM (In-service Drag) tests required
 - » 10 snubbers or 10% (smaller of two) each outage
 - » Supplemental samples of equal size tested for each failure

Typical Snubber Tech Spec Visual Table from 1980's

SURVEILLANCE REQUIREMENTS

4.7.9 Each snubber shall be demonstrated OPERABLE by performance of the following augmented inservice inspection program and the requirements of Specification 4.0.5.

a. Visual Inspections

The first inservice visual inspection of snubbers shall be performed after four months but within 10 months of POWER OPERATION and shall include all snubbers within the scope of Specification 3.7.9. If less than two (2) snubbers are found inoperable during the first inservice visual inspection, the second inservice visual inspection shall be performed 12 months $\pm$ 25% from the date of the first inspection. Otherwise, subsequent visual inspections shall be performed in accordance with the following schedule:

<u>No. Inoperable Snubbers per Inspection Period</u>	<u>Subsequent Visual Inspection Period*#</u>
0	18 months $\pm$ 25%
1	12 months $\pm$ 25%
2	6 months $\pm$ 25%
3,4	124 days $\pm$ 25%
5, 6, 7	62 days $\pm$ 25%
8 or more	31 days $\pm$ 25%

The snubbers may be categorized into two groups: Those accessible and those inaccessible during reactor operation. Each group may be inspected independently in accordance with the above schedule.

History of Snubber Program Requirements (cont.)

- NRC Revised Requirements
 - 1980, 1984 Generic Letters addressed revised Tech Spec requirements
 - Primarily formed basis for most "Original" Tech Specs (Pre-ITS)
 - All sizes included
 - Categorization of snubbers by design
 - In-service drag test requirements for hydraulic snubbers removed
 - Various sample plans offered
 - Generic Letter 80-99 revised TS and added requirements for mechanical snubbers
 - Activation and drag tests required
 - Freedom of Motion Tests
 - 1981 – IE 81-01 addressed “frozen” INS mechanical snubbers
 - Generic Letter 84-13 eliminated snubber list from Tech Specs

Typical Tech Spec Snubber List

TABLE 3.7-4a

SAFETY RELATED HYDRAULIC SNUBBERS*

<u>SNUBBER NO.</u>	<u>SYSTEM SNUBBER INSTALLED ON, LOCATION AND ELEVATION</u>	<u>ACCESSIBLE OR INACCESSIBLE (A or I)</u>	<u>HIGH RADIATION ZONE DURING SHUTDOWN** (Yes or No)</u>	<u>ESPECIALLY DIFFICULT TO REMOVE (Yes or No)</u>
2MS-R534	Aux. Bldg., E1. 179'-7-3/16" Col. Lines T15 & T16 TA & TA	A	No	Yes
2MS-R532#	Aux. Bldg., E1. 155'-7-3/8" Col. Lines TA & A 31 & 34	A	No	Yes
2MS-R533	Aux. Bldg., E1. 155'-7-3/8" Col. Lines TA & A 31 & 34	A	No	Yes
2MS-R517	Aux. Bldg., E1. 130'-2" Col. Lines C & D 34 & 36	A	No	Yes
2MS-R516#	Aux. Bldg., E1. 130'-2" Col. Lines C & D 34 & 36	A	No	Yes
2MS-R503#	Aux. Bldg., E1. 130'-2" Col. Lines C & D 31 & 34	A	No	Yes
2MS-R505	Aux. Bldg., E1. 130'-2" Col. Lines C & D 31 & 34	A	No	Yes
2MS-R510	Aux. Bldg., E1. 130'-2" Col. Lines C & D 31 & 34	A	No	Yes
2MS-R522	Aux. Bldg., E1. 147'-0-11/16" Col. Lines A & B 31 & 34	A	No	Yes

Snubber List Commitment

SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 55 TO FACILITY OPERATING LICENSE NO. NPF-2

AND AMENDMENT NO. 46 TO FACILITY OPERATING LICENSE NO. NPF-8

ALABAMA POWER COMPANY

JOSEPH M. FARLEY NUCLEAR PLANT, UNIT NOS. 1 AND 2

DOCKET NOS. 50-348 AND 50-364

Introduction

Alabama Power Company (APCo) by letter dated July 6, 1984, requested amendments to the Farley Units 1 and 2 Technical Specifications (TSs). The proposed amendments consist of revisions to the snubber Technical Specifications (Section 3/4.7.9) pursuant to NRC Generic Letter 84-13 and miscellaneous administrative changes to other sections of the Technical Specifications. Our evaluation follows.

Evaluation

The licensee proposed to delete Tables 3.7-4a and 3.7-4b from the Units 1 and 2 Technical Specifications. Deletion of these tables, which list safety-related snubbers, will eliminate the need for frequent TS amendments to incorporate changes in the snubber listings. This change is in accordance with guidance issued to all licensees in NRC Generic Letter 84-13, dated May 3, 1984, Subject: Technical Specification for Snubber (Generic Letter 84-13). The licensee will maintain the listing of safety-related snubbers in the plant surveillance procedures. Changes to these lists are subject to the provisions of 10 CFR 50.59.

History of Snubber Program Requirements (cont.)

- Section XI
 - 1978 ASME Section XI IWF-5000 introduced (Winter addenda)
 - Small bore only (< 50 kips)
 - 10% testing only, representative
 - Rotate through population
 - 1982 NRC Rulemaking endorsed Section XI for first time
 - 1987 Addenda
 - added reference to OM Part 4 (in preparation)
 - Added examinations (referenced VT-3, IWA-2213)
 - Added attachments
 - Dropped size limit
 - Removed test and sample details
 - 1989 Incorporated dates (OM-1987 published in 1988)
 - 1992 Removed OM publication dates
 - 2006 Addenda deleted snubbers from ISI

Section XI Article IWF

SUBSECTION IWF REQUIREMENTS FOR CLASS 1, 2, 3, AND MC COMPONENT SUPPORTS OF LIGHT-WATER-COOLED PLANTS

ARTICLE IWF-1000 SCOPE AND RESPONSIBILITY

IWF-1100 SCOPE

This Subsection provides the requirements for inservice inspection of Class 1, 2, 3, and MC component supports.

IWF-1200 COMPONENT SUPPORTS SUBJECT TO EXAMINATION AND TEST

IWF-1210 EXAMINATION REQUIREMENTS

The examination requirements shall apply to the following:

- (a) piping supports
- (b) supports other than piping supports

IWF-1220 SNUBBER INSPECTION REQUIREMENTS⁴⁰

The inservice inspection requirements for snubbers are outside the scope of this Division.

IWF-1230 SUPPORTS EXEMPT FROM EXAMINATION

Supports exempt from the examination requirements of [Article IWF-2000](#) are those connected to piping and other items exempted from volumetric, surface, or VT-1 or VT-3 or general visual examination by [IWB-1220\(a\)](#) through [IWB-1220\(c\)](#); [IWC-1221](#), [IWC-1222](#); [IWD-1220\(a\)](#) through [IWD-1220\(d\)](#); and [IWE-1220\(a\)](#), [IWE-1220\(c\)](#), and [IWE-1220\(d\)](#). In addition, portions of supports that are inaccessible by being encased in

concrete, buried underground, or encapsulated by guard pipe are also exempt from the examination requirements of [Article IWF-2000](#).

IWF-1300 SUPPORT EXAMINATION BOUNDARIES

The support examination boundaries for both integral and nonintegral supports are shown in [Figure IWF-1300-1](#). The following definitions apply.

(a) The boundary of an integral support (B) connected to a pressure-retaining component (A) is the distance from the pressure-retaining component (A) as indicated in [Subsection IWB](#), [Subsection IWC](#), [Subsection IWD](#), and [Subsection IWE](#).

(b) The boundary of an integral support (C) connected to a building structure (E) is the surface of the building structure.

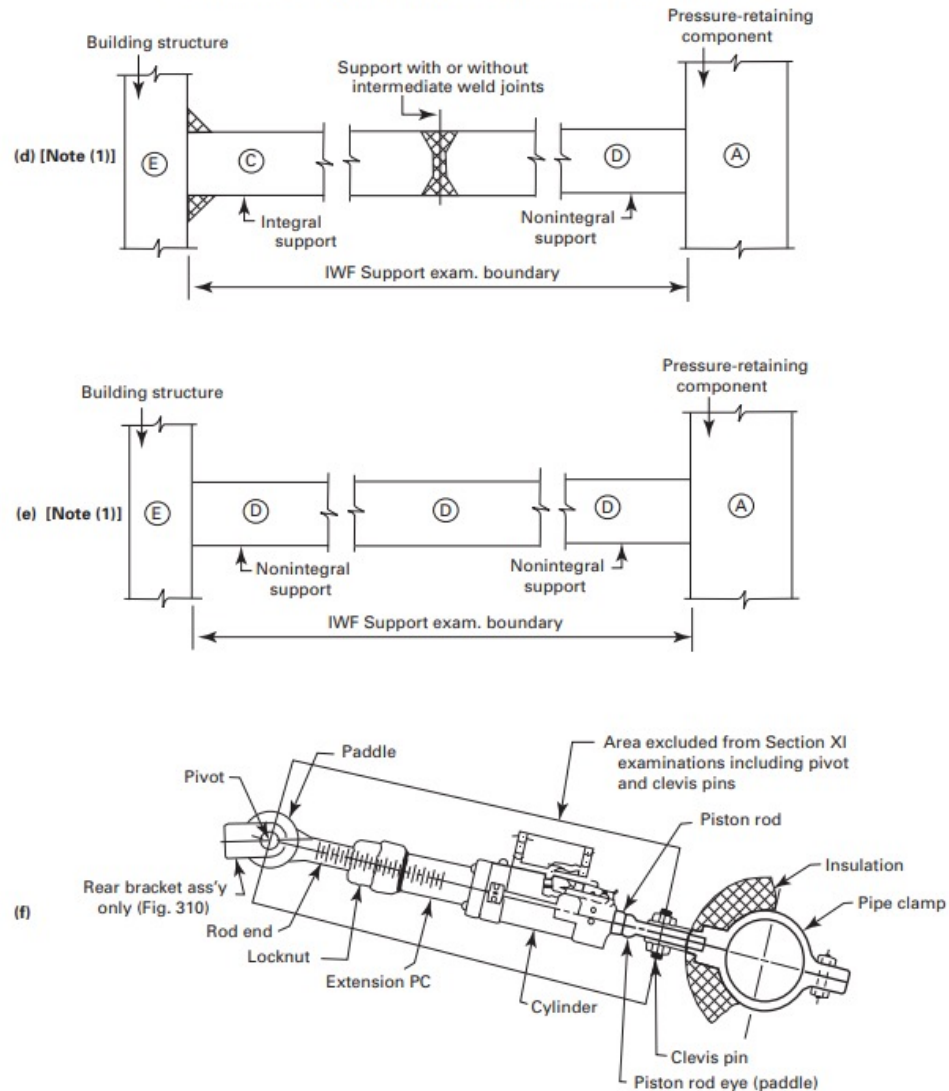
(c) The boundary of a nonintegral support (D) connected to a pressure-retaining component (A) is the contact surface between the component and the support.

(d) The boundary of a nonintegral support (D) connected to a building structure (E) is the surface of the building structure.

(e) Where the mechanical connection of a nonintegral support is buried within the component insulation, the support boundary may extend from the surface of the component insulation, provided the support is under continuous tension or compression load.

Section XI Figure IWF-1300-1

Figure IWF-1300-1
Illustrations of Typical Support Examination Boundaries (Cont'd)



History of Snubber Program Requirements (cont.)

- ASME OM-4 / ISTD
 - Working Group formed in late 1970's
 - Tasked to develop pre-service and in-service snubber examination requirements (OM Part 4)
 - OM Part 4 issued as OMA-1988 addenda to 1987 OM Code
 - Eventually became Subsection ISTD of OM-1990
 - Two Test Plans
 - 10% Plan
 - 37 Plan

History of Snubber Program Requirements (cont.)

- Improved Technical Specifications
 - Improved Tech Specs (ITS) mid - late 90's
 - Relocated snubbers to Owner Controlled Documents (TRMs)
 - Requirements unchanged (cut & paste from Tech Spec to Owner Controlled Document)
 - Changes per 10CFR50.59 possible
 - LCO for snubbers was lost for most sites

History of Snubber Program Requirements (cont.)

Comparison of Early Tech Specs / Later Tech Specs / Section XI / OM Code

The tables on the following slides will provide a comparison of the following topics over several program guidance documents:

- Scope
- Examination Boundary
- Personnel Certifications
- Test Plans
- Failure Mode Grouping
- Drag Testing
- Service Life Monitoring

Scope Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI IWF (1978- 1987a)	Section XI IWF (1987a-2006)	OM-4 (1988)	ISTD (ISTA) (1990)
All Safety Related Hydraulic Snubbers	All Safety Related Snubbers + Snubbers Affecting SR Systems	Class 1, 2, 3, & MC Snubbers with Load ratings < 50 kips <u>Testing Only</u>	Class 1, 2, 3, & MC Snubbers <u>Added Examinations</u>	All Safety Related Snubbers	RC Pressure Boundary, Achieve or Maintain Safe Shutdown, Mitigate Accident

Boundary Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI IWF (1978- 1987a)	Section XI IWF (1987a- 2006)	Section XI IWF (2006)	OM-4 (1988)	ISTD (1990)
Pipe to Building Structure	Pipe to Building Structure	Pipe to Building Structure	Refers to OM-4	Excludes snubber Pin to Pin	Pipe to Building Structure	Pin to Pin

Certification Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI IWF (1987a)	OM-4 (1988)	ISTD (1990)
None	None	VT-3 Method required	Per Owner's Reqs.	Per Owner's Reqs

Test Plan Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI IWF (1978a)	Section XI IWF (1987)	OM-4 (1988)	ISTD (1990)
10% or 10 No FMG	10%, 37 (others, 88,55,etc) No FMG	10% No FMG	Refers to OM-4 (pointer removed in 2006 Addenda)	10%, 37 Mandatory FMG	10%, 37 Optional FMG

Drag Test Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI (1978a)	Section XI (1987)	OM-4 (1988)	ISTD (1990)
Hyd. Breakaway & Running	Mech. Breakaway & Running	Hyd.&Mech Breakaway & Running	Refers to OM-4 (pointer removed in 2006 Addenda)	Mech. Breakaway & Running	Mech. Running

Service Life Comparisons

Early TS (1980)	Later TS (TRMs) (1994)	Section XI (< 1987)	Section XI (1987)	OM-4 (1988)	ISTD (1990)
None	Yes	None	Refers to OM-4 (pointer removed in 2006 Addenda)	None	Yes

Current Requirements

- General Program Requirements Today
 - Visual Examination
 - Functional Testing
 - Service Life Monitoring
 - Documentation
 - Maintain Listing of Snubbers
 - Maintain Service Life data
 - Design/Licensing Basis of Program (site specific)
 - Implementation (actions taken)
 - NUREG 1482 addresses Program requirements

Current Requirements

- Applicable Site-Specific Licensing Basis for Requirements
 - Technical Specifications (in some cases LCOs only)
 - Owner Controlled Documents (TRMs)
 - Section XI (Prior to 2006 addenda)
 - OM-4 (none currently)
 - ISTD
 - Relief Requests
- Reconciliation of Multiple Basis Documents
 - Must define ALL governing requirements for the Program
 - If Tech Specs/TRM do not match the governing Code then both sets of requirements must be satisfied
 - If applicable, Section XI requirements must be met unless relief is granted

Current Requirements (cont.)

— Recent & Future Changes

- Section XI Article IWF-5000 Deleted in 2006 Addenda
- Subsequent to 2006a all Snubber In-Service Requirements to be in accordance with OM ISTD
- **NRC rulemaking requires ISTD if using SC XI 2006 addenda or later**
- Any exception requires an approved Relief Request
- Must update TS/TRM/Commitments/Procedures to incorporate or reference OM ISTA and ISTD.

Historic Reference Documents

- There are many historical documents that drove the evolution of snubber examination, testing, and service life requirements to current practices.
- NRC, manufacturers, INPO, EPRI, etc.
- Some provide good background information; others simply show the early industry lack of understanding.
- Many are readily available, others not so much.
- The list provided is not all inclusive but meant to convey the long history and depth of input that got us where we are today – both the good and the bad.

NRC Generic Letters & Bulletins

Generic Letters

GL 80-99, Surveillance Requirements for Mechanical Snubbers

GL-84-13, Technical Specification For Snubbers

GL-89-09, ASME Section III Component Replacements

GL 90-09, Visual Inspection Frequency

GL 91-18, Operability Guidelines

Bulletins

B73-03, Defective Hydraulic Shock Suppressors

B73-04, Defective Bergen Paterson Hydraulic Shock Suppressors

B75-05, Operability of Hydraulic Shock Suppressors

B78-10, Bergen-Paterson Hydraulic Shock Suppressor Accumulator
Spring Coils

B79-02, Pipe Support Anchor Bolts

B79-14, Configuration Verification

B81-01, Failures/Surveillance of Mechanical Snubbers

NRC Information Notices

N79-01, Bergen-Paterson Hydraulic Shock Arrestors

N79-05, Improper Materials in Safety Related Components

N80-42, Radiation Effects on Hydraulic Snubber Fluid

N82-12, Failure/Surveillance of Hydraulic Snubbers

N83-13, Misapplication of Bergen-Paterson Clamp

N83-20, ITT-G Fig. 306/307 Mechanical Snubber Attachment Interference

N83-47, Failure of Hydraulic Snubbers

N84-67, Recent Snubber Testing High Failure Rate

N84-73, Down Rating of Self Aligning Ball Bushings

N86-102, Repeated Multiple Failures of SG Snubbers

N88-95, Inadequate Validation of Procured Parts for Anchor/Darling
Mechanical Snubbers

NRC Information Notices

N89-30, High Temperature Environment

N94-48, High Temperature Environment

N95-09, Use of Inappropriate Guidelines/Criteria for Operability
Evaluations of Pipe and Supports

N97-16, Pre-conditioning of Components Prior to IST

N97-71, Inappropriate Use of 50.59 Regarding Reduced Seismic
Criteria for Temporary Conditions

NRC RIS & EGM

RIS 2010-06, Inservice Inspection and Testing Requirements of
Dynamic Restraints (Snubbers)

EGM 10-001, Enforcement Guidance Memorandum, Dispositioning
Violations for Inservice Examination and Testing
Requirements for Dynamic Restraints (Snubbers)

NRC Circulars

C76-05, Bleed and Lock-up Velocities on ITT-Grinnell Figure 200 and 201 Hydraulic Shock Suppressors

C78-07, Damaged Components of Bergen-Paterson Series 25000 Test Stand

C79-25, Bergen-Paterson Shock Arrestor Strut Assembly Interference

C81-05, Self-Aligning Rod End Bushings for Pipe Supports

NRC NUREGs

NUREG-371

NUREG-933

NUREG-1482

CR-2175, Snubber Sensitivity Study

CR-2032, Single Vs. Dual Snubber Installations

CR-2136, Effects of Postulated Event Devices on Normal Operation of Piping Systems in Nuclear Power Plants

CR-4279, Aging and Service Wear of Hydraulic and Mechanical Snubbers Used on Safety-Related Piping and Components of Nuclear Power Plants

CR-5386, Basis for Snubber Aging Research

CR-5416, Generic Issue 113, Dynamic Qualification and Testing of Large Bore Hydraulic Snubbers

CR-5646, Piping System Response During High Level Simulated Seismic test at the Heissdampfreaktor Facility (SHAM Test Facility)

CR-5870, Results of LWR Snubber Aging Research

CR-6027, Evaluation of Snubber Single Failures

EPRI Documents

NP-2297	Snubber Reliability Improvement Study
NP-5854	Assessing the Costs, Risks, and Benefits of Snubber Reduction: A Comprehensive Framework (June 1988).
NP-6443	Improved Criteria for Snubber Functional Testing, July 1989.
NSAC-104	Guidelines for Reducing Snubbers on Nuclear Piping Systems
TR-1010968	Tier 2, Volume 1, Guidelines and Criteria for Nuclear Piping and Support Evaluation and Design, Integration of Methods and Guidelines to Evaluate Nuclear Piping and Pipe Support Design and Operability Issues. (Not NRC endorsed)
TR-1010968	Tier 2, Volume 4, Guidelines and Criteria for Nuclear Piping and Support Evaluation and Design, Behavior and Failure Mode of Standard Pipe Supports Beyond Their Design Conditions
TR-102363	Tier 1 & 2, Evaluation of Snubber Functional Test Methods.
TR-6270-1	Snubber Reduction Program (October 1985)

INPO Documents

86-014, Good Practice MA-313, “Snubber Maintenance Program”
(never formally approved)

OMRs (Operations and Maintenance Reminders)

- OMR-19, Grinnell Snubber Orientation
- OMR-20, Corroded INS Mechanical Snubbers
- OMR-38, Grinnell Snubber Orientation
- OMR-83, ITT Grinnell Hydraulic Snubbers
- OMR-115, Steam Generator Snubber Failures
- OMR-146, Failure of PSA Mechanical Snubbers
- OMR-223, Waterhammer in RHR System Damages Snubber
- OMR-310, Aux. Feedwater Pump Trip

SERs (Significant Event Reports)

- SER22-81, Corrosion Failure of Mechanical Snubbers
- SER54-81, ECCS Piping Damaged
- SER90-81, High Occurrence of Degraded Hydraulic Snubbers

Technical Reports

- Combustion Engineering Report 82-02,
Installation of Grinnell Hydraulic Snubbers
- General Electric Report SIL021,
Seals for Bergen-Paterson Hydraulic Shock Suppressors
- General Electric Report SIL021S1,
Seals for Bergen-Paterson Hydraulic Shock Suppressors
- General Electric Report SIL021S2,
Seals for Bergen-Paterson Hydraulic Shock Suppressors
- General Electric Report SIL021S3,
Seals for Bergen-Paterson Hydraulic Shock Suppressors
- General Electric Report SIL021S4,
Snubber Surveillance Program
- General Electric Report SIL021S5,
Seals for Grinnell Hydraulic Shock Suppressors
- General Electric Report SIL070,
Hydraulic Shock Suppressor Application
- General Electric Report SIL339,
Mechanically Locked Snubbers



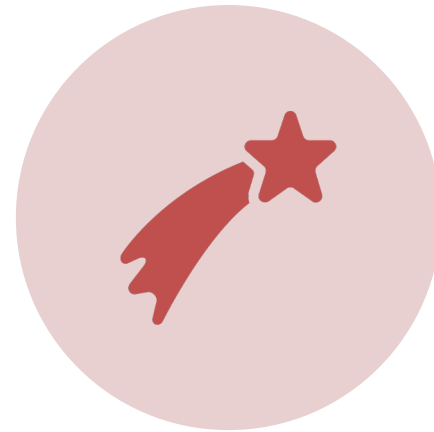
QUESTIONS?



COMMENTS?



THANK YOU FOR YOUR TIME.



WE HOPE YOU HAVE LEARNED
SOMETHING TODAY.

MORNING BREAK
SPONSORED BY



RETURN BY 10:30 AM



S N U B B E R U S E R S G R O U P

**Late Registration is Open
Session will start at 10:30 AM**

PLEDGE OF ALLEGIANCE

Before we call the conference to order,
please join us in the Pledge of Allegiance
to the American Flag.





S N U B B E R U S E R S G R O U P

SNUBBER USERS GROUP 2023 SUMMER CONFERENCE & TRADE SHOW

Call To Order
Mitch Etten-Bohm

WELCOME!!



- **Administrative Items & Announcements**
 - Safety
 - Agenda Changes
 - Forms in your booklet
 - Question Cards/Benchmarking Cards
 - SNUG Inc. Business Meeting
 - Board Meeting after today's session to elect officers for 2023-2024
 - Special Event Tonight



MORNING AGENDA

Agenda

- Welcome and Special Events – Lisega
- Introductions
- Vendor Products and Services



Welcoming Remarks



LISEGA

Welcome to Tucson, AZ!!

- Casino Del Sol
 - Over a dozen dining restaurants to choose from
 - Multiple bars
 - Casino
 - Let us know if there is anything you need
- Group Entertainment
 - Top Golf on Monday
 - Buses to leave at 5:30 PM
 - Food and golf from 6-9 PM

INTRODUCTIONS

- Name
- Utility/Vendor
- Years with snubbers
- What do you want out of this conference?



Participating Vendors



***CURTISS -
WRIGHT***





ASC[™]

Engineered Solutions

Barker/Diacon

Snubber Test Equipment

THE FORCE IN SNUBBER TESTING

1310 Miller Rd. Greenville, SC 29607

800-349-3149

jeff@barkerproducts.net nathaniel.potter@diaconcorp.com

www.barkerproducts.com www.diaconcorp.com

Snubber Test Bench Systems



Barker/Diacon

Snubber Test Bench Upgrade



Barker/Diacon

In-Place Test Machine

Model IPST-10

Quick Simple Setup & Operation

- Versatile, Continuous Duty Rated
- Activation Flow Rates to 18 GPM
- Max Pressure to 12,000 PSI
- Test snubbers, filter fluid or use as a flow bench to adjust control valves
- Operators can be up to 100 feet from snubber and instrument box
- Test snubbers as large as 20" bore and as small as 2 1/2" bore



Barker/Diacon

Portable Filter Machine

Model PFM-02

Stage 1

Dirt and Water Removal:

This Filter Stage removes both solid contaminants and water. 25 Micron Impregnated paper for dirt removal
Open Cell absorbent polymer water removal

Stage 2

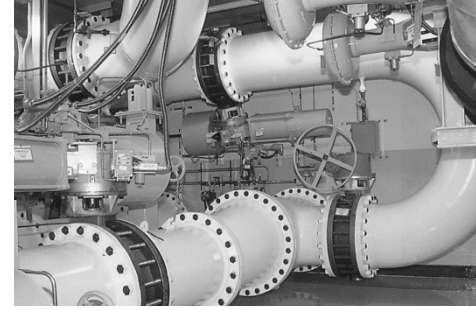
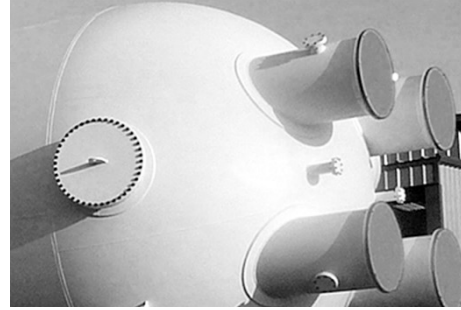
Polishing Element:

Filters suspended contaminants to 1 Micron in diameter Removal of oxidation and decomposition products from synthetic fluids



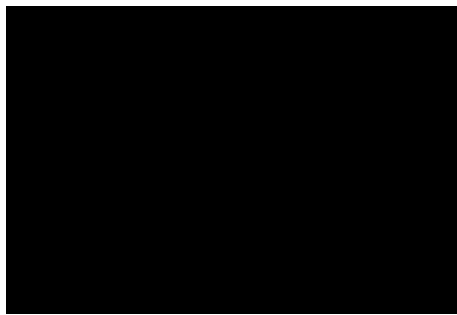
Fill the reservoir with fluid, set the timer and flow speed switches, and this machine will filter the fluid "Unattended" until the timer switch runs out. When either of the filter elements become dirty, the machine will automatically shut down. Warning lights on the panel will tell the operator that the filter elements need to be changed before the machine can be restarted. Fluid can be poured directly into the reservoir, or drawn from an external source by changing the external suction ball valve position

Barker/Diacon



Curtiss-Wright Nuclear

Enertech - Overview



Curtiss-Wright Snapshot



\$2.5B 2022E Sales

\$5.2B Market Cap

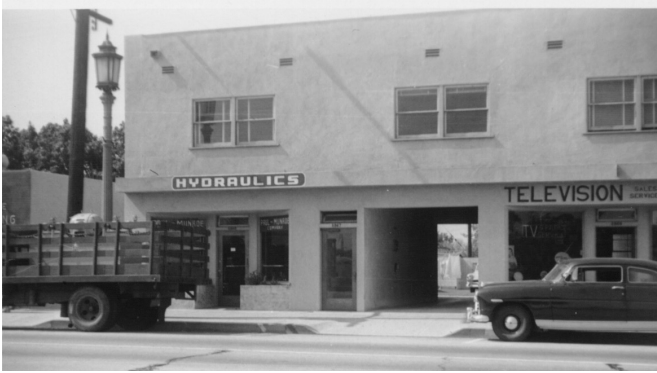
90 Countries Served

40 Major Sites (>50 employees)

7.8k Employees

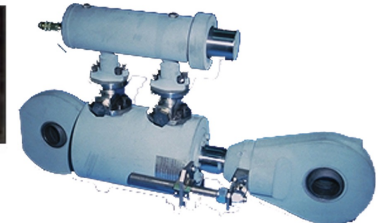
1.8k Engineers

Enertech Early Beginnings

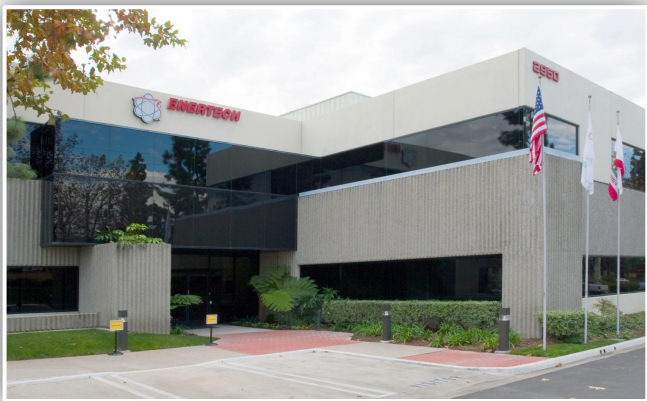


- Paul-Munroe Hydraulics Inc.
- California hydraulic distributor, manufacturer
- Enertech established 1987: P-M Energy Products

- Technology-defined company
- Hydraulic snubbers, EHOs
- Bettis distributor



Brea Operations



70,000 sq. ft.
2 locations

100+ Employees Dedicated to Nuclear

On-Site
Machining



On-Site
Testing



5,000 sq. ft.
Welding Area



Multiple
Bridge Cranes



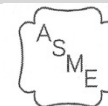
Indoor
Truck Bay



Quality Standards

ASME Scope: Class 1,2,3

pressure vessels, pumps, valves, mc vessels, piping systems, appurtenances and supports



QA programs meet:

ASME Section III NCA3800 & 4000

ASME Section XI – IWA 4400

Nat'l Board – NBIC-23 NR Stamp

ANSI N45.2

10CFR50 Appendix B

10CFR Part 21

CAN/CSA N285, Z299, B51

ISO 9001:2015

Additional standards / certifications

IEEE 323, 344, 382

*EPRI NP5652 & TR102260; NP7218 & TR
0171218 R1*

ANS 56.2 Appendix J

ASME NQA-1

AFCEN RCC-M

CRN / T.S.S.A. (Canada)

HAF 604 (China)

CNCAN-Romania

ISCIR - Romania

*NUPIC audited under
observation of the NRC*

NIAC member audited

*Routine vendor
inspection by NRC*

Engineering Background, Experience & Capabilities

NUCLEAR EXPERIENCE

Exclusively Serving the Nuclear Power Industry Since 1967...

Knowledgeable, Experienced and Diverse Engineering Team:

- **30 Nuclear-Experienced Engineers with Mechanical, Chemical and Civil Engineering Degrees**
- **8 RPEs with MS & PhD Degrees**
- **Combined Nuclear Experience of over 400 years**
- **Backgrounds from Industry, Academia, and Military**



Engineering and Analytical Services – Custom Design Solutions

■ Design and Retrofitting Capabilities

- Snubbers
- Qualified metallic support structures
- Valves and flow control devices
- Actuators and operators

■ State-of-the-Art Analysis Capabilities

- Structural/stress/thermal analysis
- Seismic analysis
- Flow analysis
- Failure root cause analysis
- Failure Mode and Effects Analysis (FMEA)

■ ASME Code and Qualification Services

- ASME QME-1 Qualification
- ASME Section III Design Reports
- ASME Sec. III RPE Representation
- IEEE 323, 344, 382 Qualification
- ASME Section IX Welding
- Commercial grade dedication services in accordance with EPRI guidelines
- MOV design basis calculations based on EPRI guidelines (GL 89-10 Sizing)

OEM Alliances

PARTNERS UNDER ENERTECH QA PROGRAM

amot

BETTIS



Conoflow®

JAMESBURY
A NELES AUTOMATION COMPANY

MAROTTA



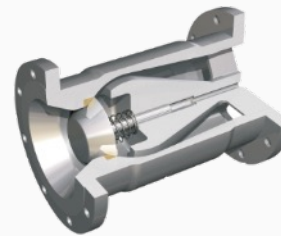
PARTNERS UNDER OEM QA PROGRAM



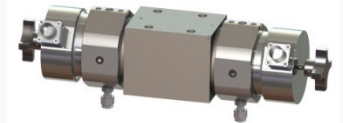
Sempell

Enertech Product Offering

VALVES



ACTUATORS



INSTRUMENTATION

PUMPS



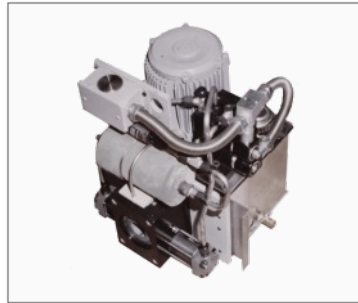
DYNAMIC RESTRAINTS

Enertech Product Offering

VALVES



ACTUATORS

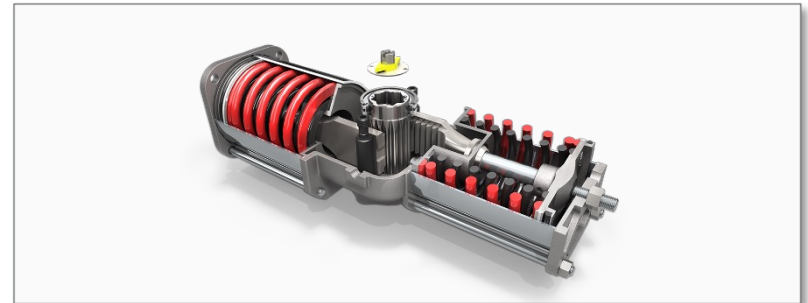


INSTRUMENTATION

PUMPS

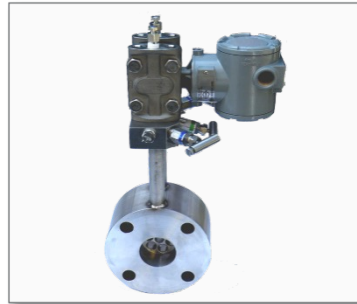


DYNAMIC
RESTRAINTS



Enertech Product Offering

VALVES

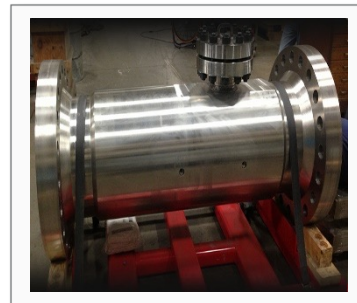


ACTUATORS



INSTRUMENTATION

PUMPS



DYNAMIC RESTRAINTS

Enertech Product Offering

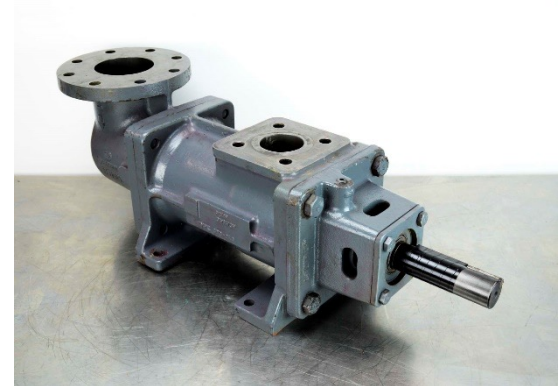
VALVES

ACTUATORS

INSTRUMENTATION

PUMPS

DYNAMIC
RESTRAINTS



Enertech Product Offering

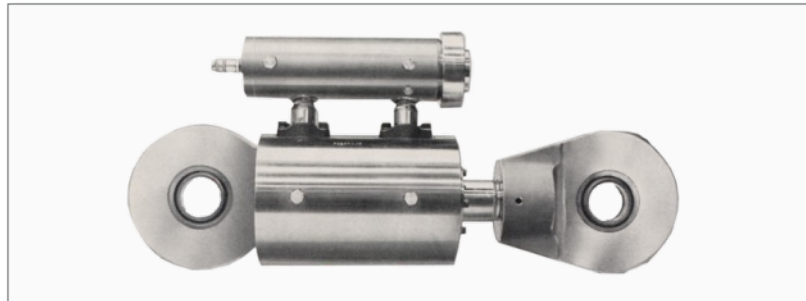
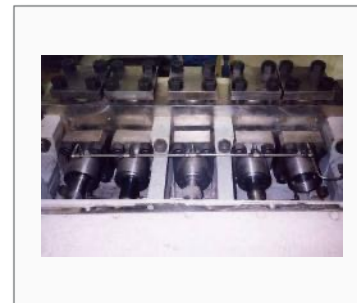
VALVES

ACTUATORS

INSTRUMENTATION

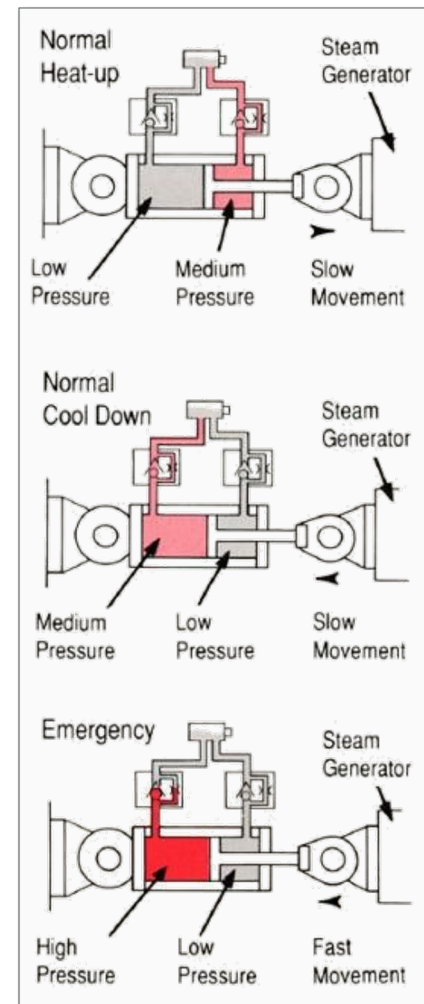
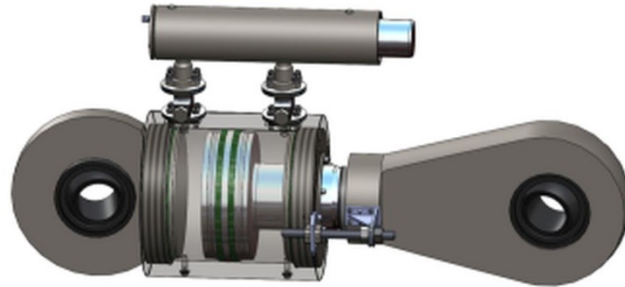
PUMPS

DYNAMIC
RESTRAINTS



Snubbers

- **Provide protection to major components during a seismic event**
 - Allows for thermal expansion and contraction during normal plant operation
- **Complete replacement, parts, and refurb support for:**
 - Enertech, Paul-Munroe, Anker-Holth/McDowell Wellman, E-Systems, Phoenix
- **Expanded onsite field service and outage support**
 - In cooperation with CW Sciencetech Outage and Field Management Solutions (OFMS) team



Large Bore Hydraulic Snubbers

Thank You

***CURTISS -
WRIGHT***

Questions?

www.cwnuclear.com





Business Profile, Capabilities & Products



Summer Conference & Trade Show
July 17, 18, & 19, 2023



Business Profile

Location

- Headquarters in Columbia, NJ
- Full Design, Manufacturing & Testing Facility
- Remote Representatives across North America

Capability

- Remote Visual Inspection (RVI) Products
- Foreign Object Search and Retrieval (FOSAR) Tools
- Custom Engineering Capabilities



Industries

- Aerospace/Aviation
- Structural Inspection/Surveillance
- General Manufacturing
- Government/Defense
- Nuclear Power Generation





Nuclear Power Generation RVI/FOSAR Products

Retrieval Tools

Up to 50 lbs gripping force at 30° closure

Motorized and Manual Tools

Articulating Guide Tubes

Video Borescopes

Inspect inaccessible areas safely & quickly

Articulating, Full-HD Portable/Benchtop Video Borescopes

XtendaCam HD Air

Extends up to 25 ft

NEW PRODUCT

< 10 lbs total weight

Tablet-based, Lightweight Pole Camera

PTZ Cameras

Various Sizes
28 - 90 mm OD

NEW PRODUCT

Use with Singular Controller/Recorder

Modular PTZ and PT Camera Heads



Xtend-a cam™ HD AIR

Features

- Camera Heads: Swappable 10x or 30x Optical Zoom
- Weight: < 10 lbs
- Pole Length: 25'
- Pole Material: Carbon Fiber w/ anti-spin notching
- Wireless Camera Interface: creates own WiFi access point
- User Interface/Display: iOS / Android Tablet/Phone
- Image/Video Capture: Touch Screen GUI
- Storage Media: Internal SSD
- IP Rating: IP50
- Battery: Commercially available, rechargeable 12V
- Battery Life: 2 hours
- Lighting: Integrated White LED
- Tilt Control: Joystick Digital Proportional Control
- Stabilization: Foot Gimble for Single Operator Control





XtendaCamTM HD AIR

Manual Inspection



Scaffolding Build/Setup
4 people, 1 shift, \$2000 cost (on avg)



Long Inspection Times



Risk of Workplace Incident
Personnel 30' feet above work areas

XtendaCam HD AIR Inspection



No scaffolding setup



Single inspector operation



10-minute inspections



Safer Workplace



VT-3 Qualified*

*InterTest customers able to get
XtendaCam qualified for VT-3 inspection work.



XtendaTM cam HD AIR



LAKE ENGINEERING COMPANY

ESTABLISHED 1984

TECHNICAL SERVICES

**SNUBBER AND PIPE SUPPORT DESIGN
SERVICES**

SEAL LIFE EVALUATION

FLUID ANALYSIS

SNUBBER AND PIPE SUPPORT TRAINING

REVERSE ENGINEERING

MATERIALS

SNUBBERS AND PIPE SUPPORTS

REPLACEMENT PARTS

SEAL KITS

SILICONE FLUIDS

MECHANICAL SNUBBER TOOLS



LISEGA

Company Overview

Dave Dutrow
Nuclear Sales Manager

Located in Kodak, TN



LISEGA Facilities



*Zeven, Germany –
Main plant*

Zeven, Germany



Kodak, USA

Kodak, TN



Bondoufle, France

Bondoufle, France



Shanghai, China

Shanghai, China



Al-Jubail, Saudi Arabia

New Delhi, India



Netherton, England

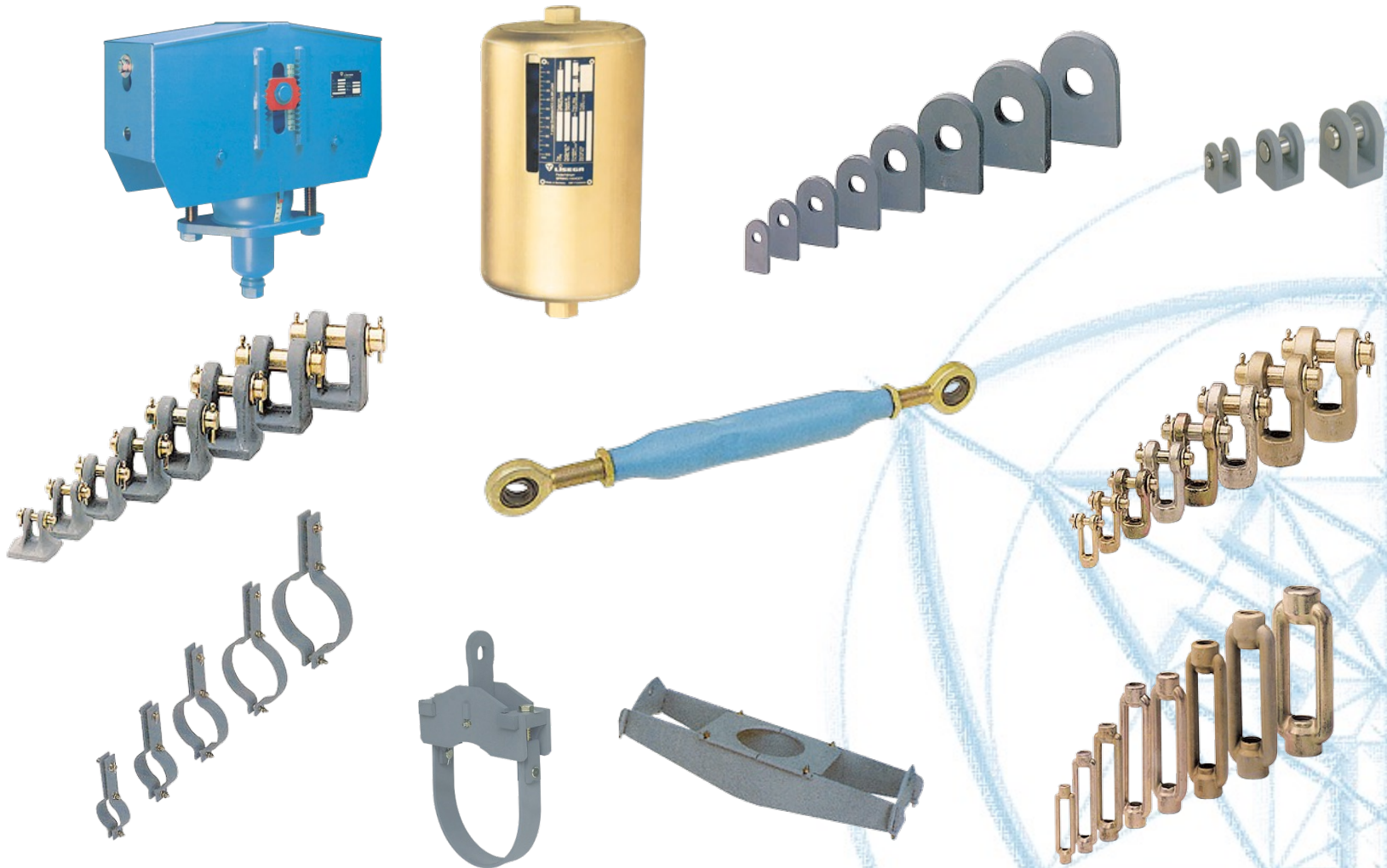
Netherton, England

*Wittenburg, Germany
(LISEGA affiliate for
connections)*

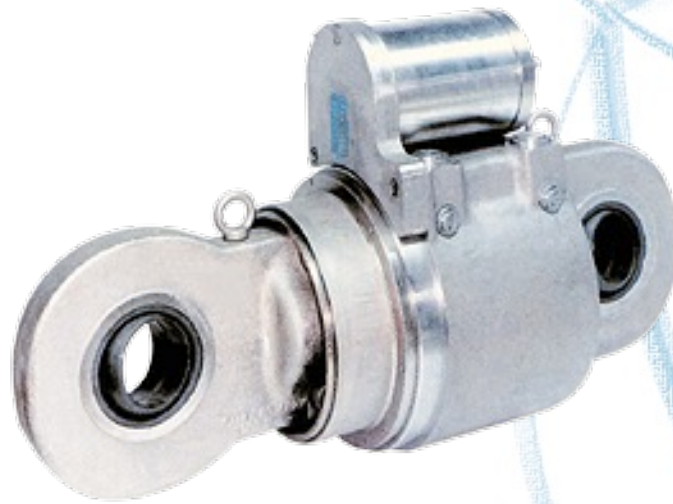


Wittenburg, Germany

LISEGA Parts



Piping & Large Bore Snubbers



Questions?



50 Years
Performance with System

SNUG 2023
Tucson, AZ



NTS

**NUCLEAR ENGINEERING
& TEST SERVICES**

www.nts.com

NTS COMPANY PROFILE



FOUNDED 1961



1200+ EMPLOYEES



**CORPORATE HQ
ANAHEIM, CA**



**26 LOCATIONS
WORLDWIDE**



**OWNERSHIP:
AURORA CAPITOL**

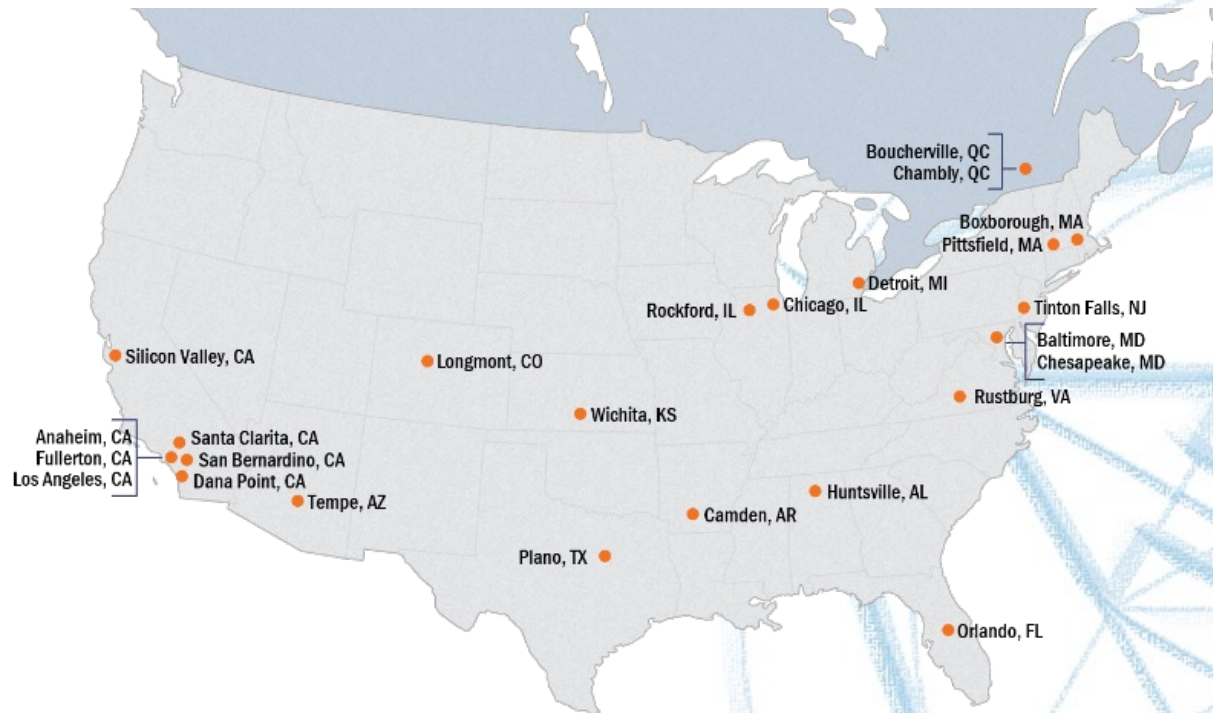


\$250 MM REVENUE



**SERVING MULTIPLE
MARKETS**

NTS NORTH AMERICA ENGINEERING SERVICE CENTERS



NTS HUNTSVILLE HIGHLIGHTS



- 160,000 sq. ft. laboratory on 92-acre facility
- Over 50 chambers, up to 30'x18'x18'
- 10 CFR 50 Appendix B Program, NQA-1, ISO 9001, A2LA Certification
- Radioactive Material License from the State of Alabama
- On-site engineering, fabrication and calibration capabilities

HIGHLY SPECIALIZED NUCLEAR TEST FACILITY



QUALIFICATION TEST SERVICES

- Four Seismic Simulators
- Six Accident Test Autoclaves
- One 150 psi, 3,000 lbs per hour boiler
- 300KW Steam Super Heater System
- One Boron Chemical Spray Injection System
- Seven EMI Test Rooms



THIRD PARTY QUALIFICATION

- Sole Supplier of Yokogawa Products
- 4000+ previously qualified items
- Cybersecurity Services
- Material Verification



VALVE TESTING SERVICES

- Three Safety Relief Valve Test Cells for steam, water and air
- UPGRADED Full Flow Steam Test System to 2,000,000 lbs/hr max and 1400 psi max
- Full Flow Hot Water Test System 2200 psi
- Hot Water Closed Loop Flow System 30,000 gallons
- Cold Water Closed Flow Loop System 60,000 gallons
- Two 3,000 psi, 6,000 lbs per hour boilers and one 1,500 psi 12,000 lbs per hour boiler

SNUBBER SERVICES



SNUBBER TEST TRAILERS



element



SNUBBER TEST MACHINE



SNUBBER TEST MACHINE



SNUBBER TEST MACHINE



HUNTSVILLE SNUBBER TEST LAB



STRATEGIC PARTNERSHIPS



US Nuclear authorized service arm for
Snubber Testing and Repair



Qualification & Supply of self-lubricating
bearings for nuclear power plants domestic
& abroad



Qualification & Supply of recorders,
controllers and replacement parts for
nuclear power plants domestic & abroad

STRATEGIC PARTNERSHIPS



Provides Full-Time Field Service Technicians to support Target Rock Valve Refurbishment at Huntsville Safety Relief Valve Test Facility.

Safety
Relief
Valves



Provides Full-Time Field Service Technicians to support Crosby, Dresser & Lonergan Valve Refurbishment at Huntsville Safety Relief Valve Test Facility.

CONTACTS

Greg Mason

Director of Nuclear Strategic
Development

256-603-0903

Greg.Mason@ntslabs.com

Eric Kelland

Nuclear Sales Manager

240-931-9002

Eric.Kelland@ntslabs.com

Keith Haney

Nuclear Sales Manager

256-698-7885

Keith.Haney@ntslabs.com

Brad Ferguson

General Manager – Nuclear
Division

256-527-9449

Brad.Ferguson@ntslabs.com

Jeromey Rucinski

Snubber Dept. Manager

256-843-9744

256-716-4292

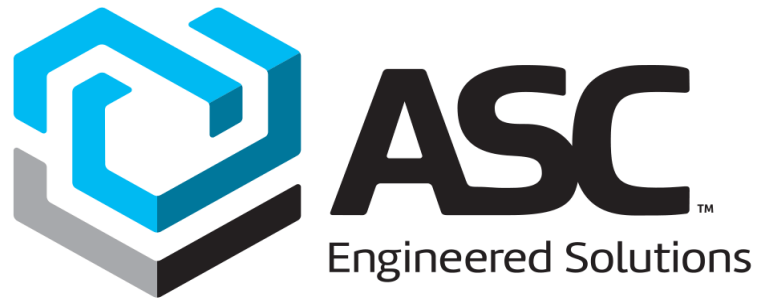
Jeromey.Rucinski@ntslabs.com

THANK YOU TAKENIE DANKU DANK DĚKUJEME DANK U MERCI KIITOS GRACIAS شكراً جزيلاً 감사합니다 धन्यवाद

one
element

element

Lunch



Building connections that last™

RETURN BY 1:00 PM

ADMINISTRATIVE ITEMS

SCOTT ESPOSITO

○ General Items

- Question Cards / Benchmarking Cards

○ Agenda Overview

- Conduct of a Snubber Testing
- Test Plots for Dummies
- Hydraulic Snubbers – Seal Life and Seal Integrity Testing
- Test Plots – Raw Data Acquisition and Analysis
- Unusual Test Plots
- Business Meeting





CONDUCT OF SNUBBER TESTING

Presented by Gus Avila &
Scott Esposito
Summer 2023 SNUG
Conference

Conducting a Snubber Test

ISTA Testing Requirements:

- ▶ ISTA-9230 Inservice Test and Examination Results
 - ▶ Component ID
 - ▶ Date of test
 - ▶ Reason for test
 - ▶ Test Procedure
 - ▶ Test Equipment ID
 - ▶ Traceability to Calibration Records
 - ▶ Measured Parameters
 - ▶ Comparison to allowable ranges and analysis of deviations
 - ▶ Corrective actions
 - ▶ Person(s) for conducting and analyzing test results

Conducting a Snubber Test

ISTA Testing Requirements:

- ▶ ISTA-9240 Record of Corrective Actions
 - ▶ Maintain Record of Corrective Actions
 - ▶ Summary of Corrective Actions
 - ▶ Printed (or typed) name and signature of person(s) responsible for the corrective action and verification of results.

Pre-Outage Snubber Testing

Organization:

- ▶ Communication – periodic meetings with Operations, Engineering, Outage Schedulers, Online Schedulers, NDE, Construction Personnel and Testing Vendor.
- ▶ Topics include:
 - ▶ Scope
 - ▶ Spare snubbers (refurbished on-site or off-site)
 - ▶ Test trailer setup or onsite testing equipment
 - ▶ Contractor test personnel, tooling, consumables, etc.
 - ▶ Visual Examinations – Pre-Removal and Post Maintenance Test
 - ▶ Package sign on process
 - ▶ Scheduling
 - ▶ Craft personnel for Removal/Installation

Pre-Outage Snubber Testing

Required Documentation:

- ▶ Engineering evaluation which classifies which snubbers meet the requirements of LCO 3.0.8. or any other evaluation
 - ▶ Does the snubber perform a function other than seismic?

Scheduling:

- ▶ Scheduled in appropriate work window
- ▶ Non-Train or Division related
- ▶ Reduced dose fields

Snubber Test Execution

Test Procedures:

- ▶ Many contain too much information – old school mentality
 - ▶ 30 to 40 pages long for each snubber test
 - ▶ Coversheets for each test containing repetitive steps
- ▶ Streamline Work Step Process
 - ▶ Testing performed by qualified individuals
 - ▶ A Main Testing Procedure (Reference Use only)
 - ▶ Forms which are a subset of the Main Testing Procedure

Snubber Test Execution

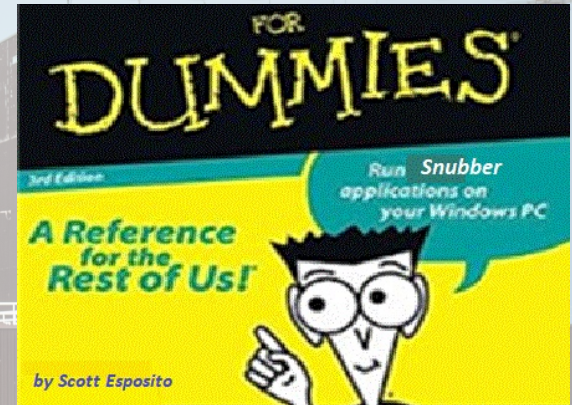
Test Report Review Documentation:

- ▶ Test Operator documents Test Results Sat/UnSat
 - ▶ Print/Signature
- ▶ Test Reviewer concurs with Test Results

Snubber Test Execution

QUESTIONS?

Test Plots



SNUG 2023

July 17, 2023

Nate Frank, AEP – DC Cook



INDIANA
MICHIGAN
POWER

COOK PLANT

An AEP Company

Information

- All are As Found Functional Tests
- Different Manufacturers as indicated
- Absolute values used in test plots
- Typically test plots are symmetrical when comparing Compression to Tension
 - if it isn't - 1st clue of a problem
 - Unusual Test Plots often indicate Imminent Failure
- Different Test Stands also used and identified

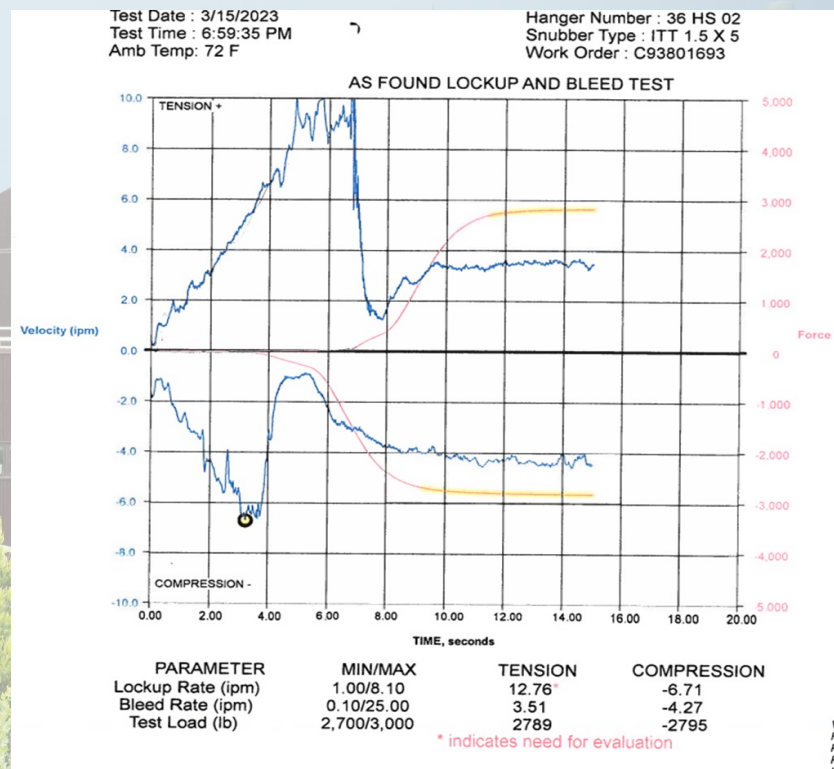


Problem Plots

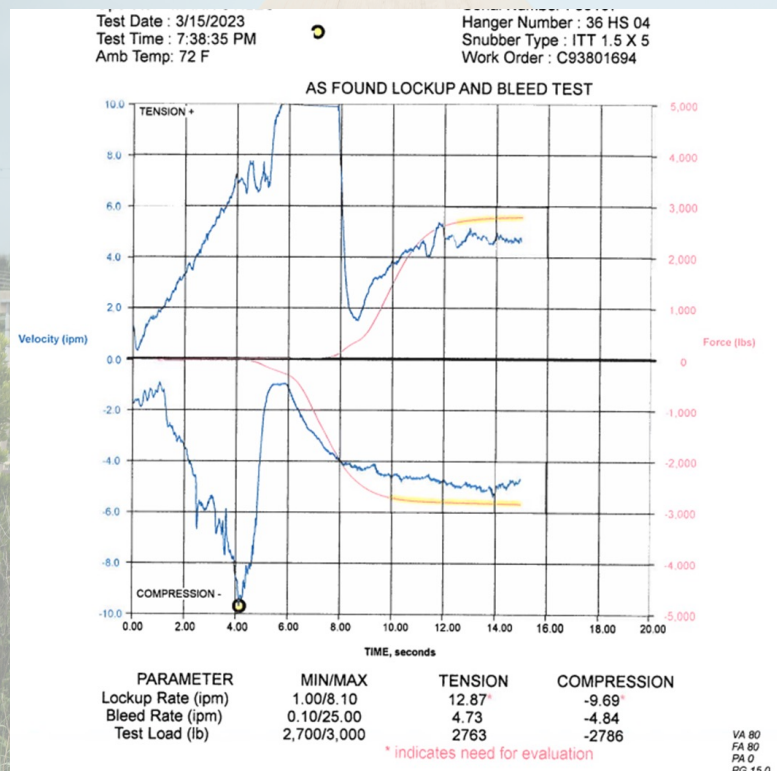
ASC/Anvil/ITT-Grinnell/ Grinnell

- 9 Mile Point Station
- Smashed Reservoir
- Does this qualify for Isolated failure ISTD 5322
- Degraded not failed perhaps?
- ISTD-5322 Isolated Failure?

Additional tests are not required for an isolated failure. All other visuals were SAT and this is external causation



Problem Plots



ASC/Anvil/ITT-Grinnell/ Grinnell

- 9 Mile Point Station
- Smashed Reservoir
- Does this qualify for Isolated failure ISTD 5322
- Degraded not failed perhaps?
- ISTD-5322 Isolated Failure?

Additional tests are not required for an isolated failure. All other visuals were SAT and this is external causation



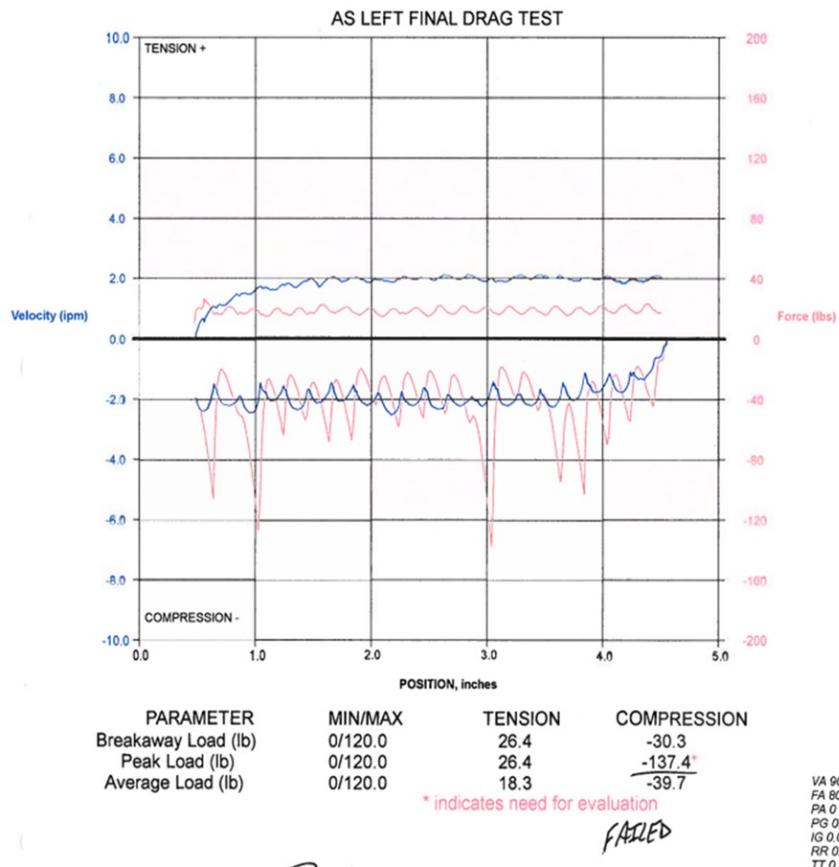
Problem Plots

PSA 3 from Ginna

- Compression Peak Load Excessive
- Note lack of symmetry
- Compression Peak Load excessive compared to allowed Maximum (abs)value

Test Date : 4/24/2023
Test Time : 9:53:33 AM
Amb Temp: 70 F

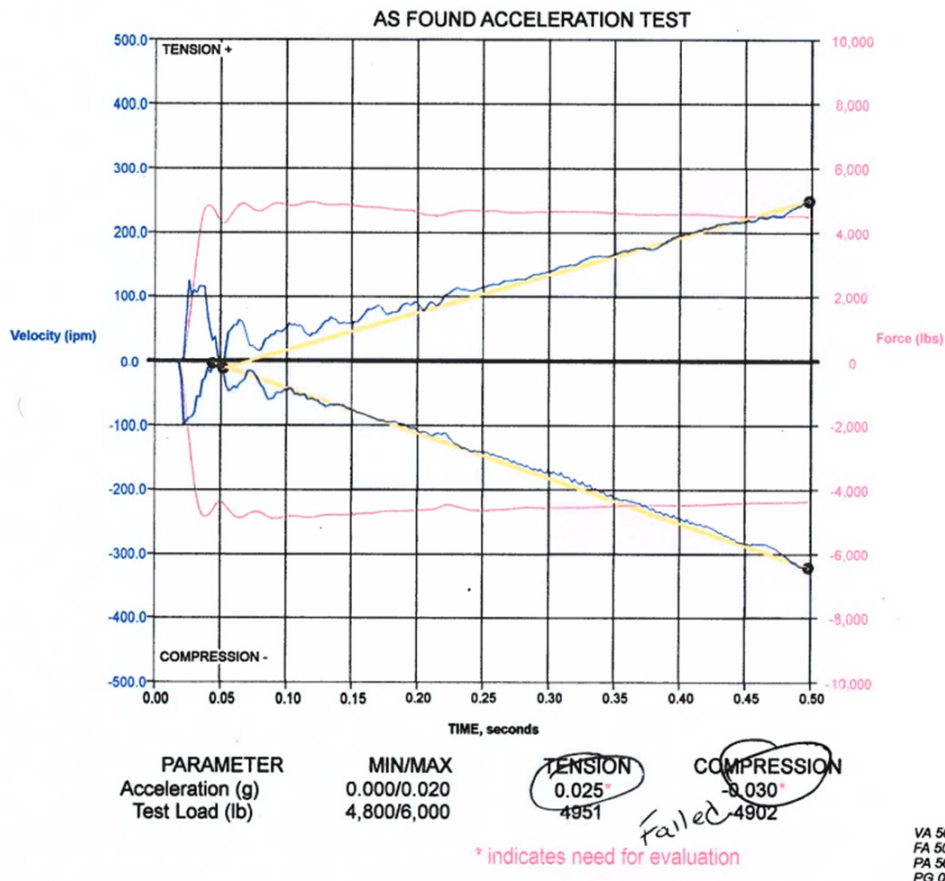
Hanger Number : MSU-55
Snubber Type : PSA 3 GINNA
Work Order : C93909502



Problem Plots

Test Date : 4/21/2023
Test Time : 3:05:11 AM
Amb Temp: 72 F

Hanger Number : MSU-80
Snubber Type : PSA 3 GINNA
Work Order : C93909253



PSA 3 from Ginna Generating Station

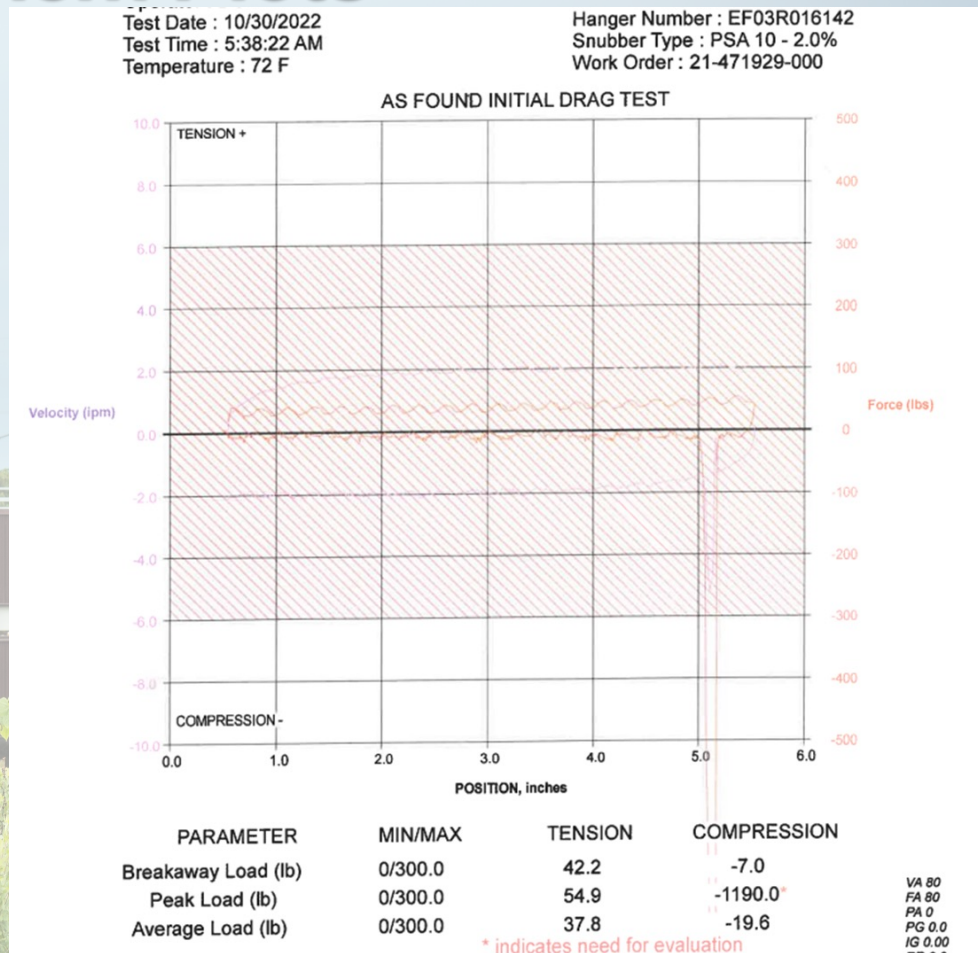
- Tension Acceleration is Excessive
- Compressive Acceleration is also excessive



Problem Plots

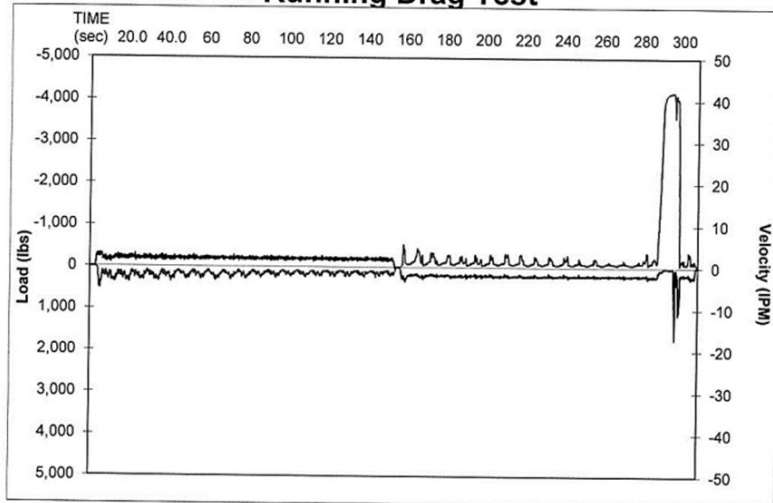
PSA 10 Larger snubber

- Computer adjusts scale
- Note outright failure down
- Peak Load in Compression is 39.667% of total and far exceeds 10% normal acceptance criteria



Problem Plots

Running Drag Test



Running Drag Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid *BR 10-5-22*
Wednesday, October 05, 2022 14:37:39

Examination Number: 100145
Mark Number: 1-SNUB-010-5052
Component Number: M-1204-1
Snubber Ser. Number: 42605
Snubber Type: PSA-10
Rated Load: 15000
Operator Comment: RUNNING DRAG (INITIAL) AS FOUND

Work Request Number: 121745876
Cold Set: 0
Service Temp: 0
Ambient Temp: 71

Average Drag Force Experienced During Run (Tension) = 161.93 lbs. (1.08%)
Peak Drag Force Experienced During Run (Tension) = 506.22 lbs. (3.37%)
Average Drag Force Experienced During Run (Compression) = 371.01 lbs. (2.47%)
Peak Drag Force Experienced During Run (Compression) = 4,196.39 lbs. (27.99%)
Acceptable Tension Average Drag Force. (lbs. < 750)
Acceptable Tension Peak Drag Force. (lbs. < 750)
Acceptable Compression Average Drag Force. (lbs. < 750)
Acceptable Compression Peak Drag Force. (lbs. < 750)

Wyle Labs Test Stand PSA 10

- Rated Load 15,000 Kip
- Peak Drag force exceeds 10%... 4,196 lbs or ~28%
- Older test stand



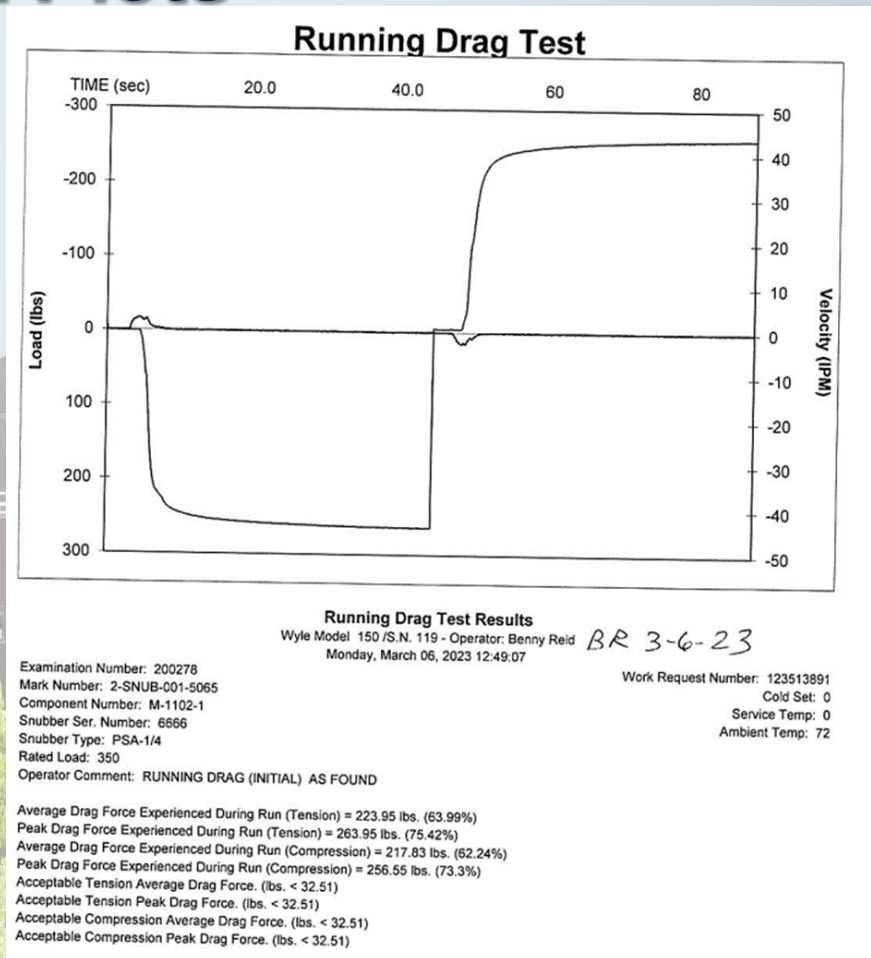
INDIANA
MICHIGAN
POWER

COOK PLANT

Problem Plots

Wyle Labs Test Stand PSA 1/4

- Rated Load 350 Kip
- Peak Drag force exceeds ~10% @ 32.51 lbs
- Reading Tension at 75.42% of capacity or ~274#s
- Reading Compression at 62% or ~257#s
- Older test stand

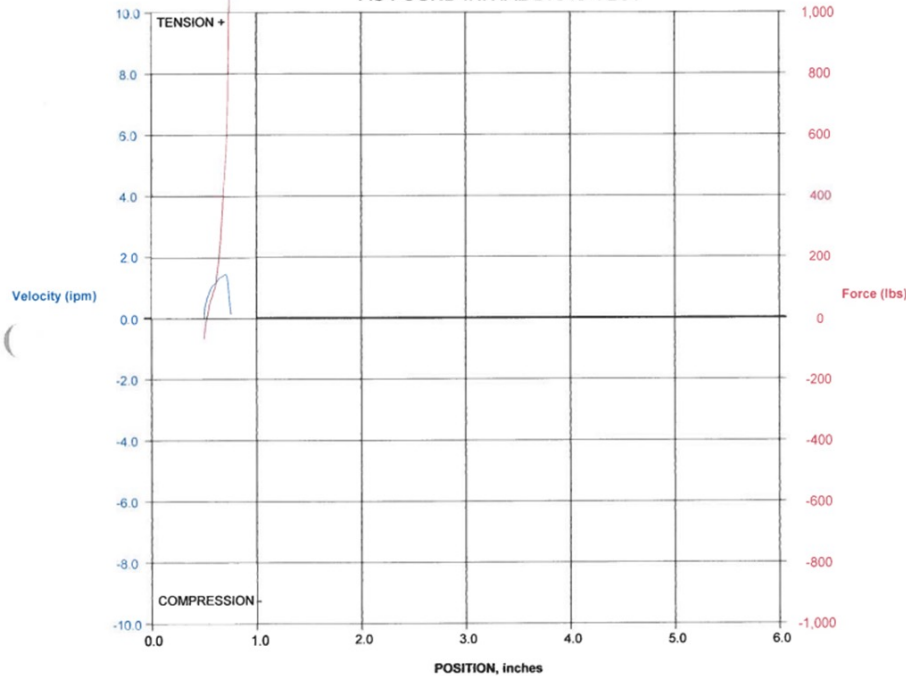


Problem Plots

Test Date : 2/15/2023
Test Time : 3:57:17 PM
Temperature : 72 F

Hanger Number : MS04-2746S
Snubber Type : PSA 10
Work Order : 05235738-02

AS FOUND INITIAL DRAG TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Breakaway Load (lb)	0/750.0	96.5	0.0
Peak Load (lb)	0/750.0	1957.6*	0.0
Average Load (lb)	0/750.0	475.2	0.0

* indicates need for evaluation

VA 80
FA 80
PA 0
PG 0.0
IG 0.00
OP 0.0

Barker/Diacon Test Stand PSA 10

- Rated Load 15,000 Kip
- Peak Drag force exceeds 10%...
4,196 lbs or ~28%
- Older test stand



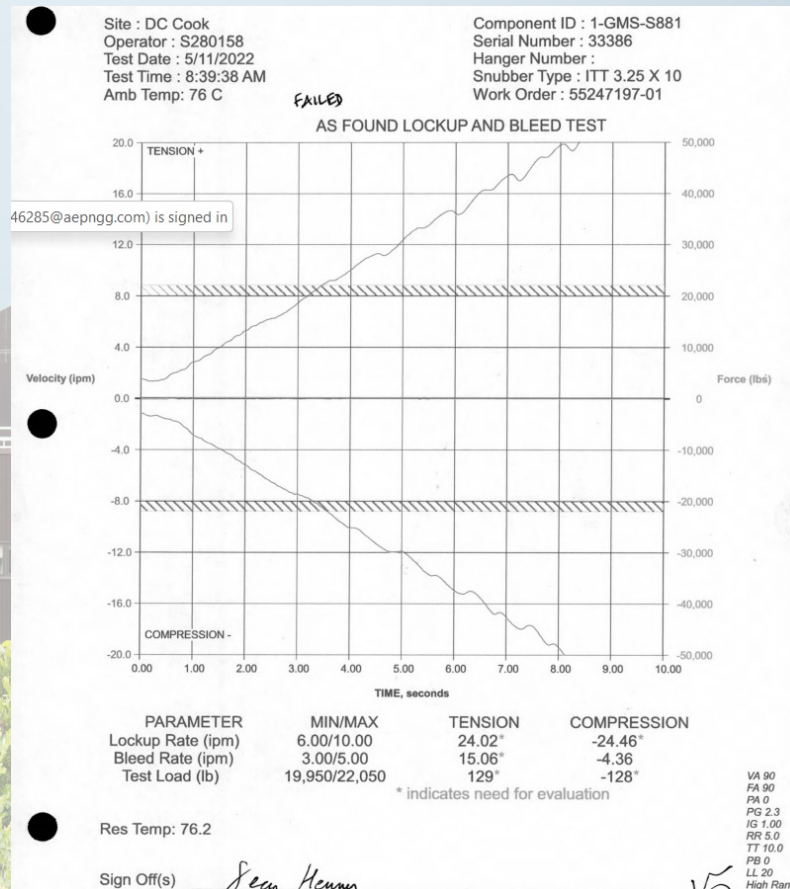
INDIANA
MICHIGAN
POWER

COOK PLANT

Problem Plots

AEP – Cook Plant

- Barker/Diacon Test Stand
- Rated Load 21 Kip
- Anvil 3.25x10 Fig 201 Config A
- Installed in 1998
- Pushed off MS Visuals to allowed 2 cycles due to COVID-19
- Started(& Finished) leaking between cycles
- Loss of Fluid

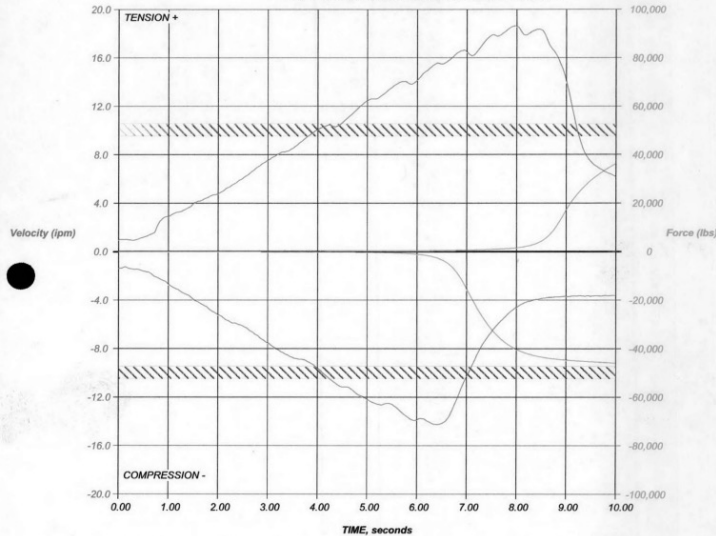


Problem Plots

Site : DC Cook
Operator : S280158
Test Date : 4/2/2022
Test Time : 12:17:31 PM
Amb Temp: 74 C

Component ID : 1-AFW-S4039
Serial Number : 40710
Hanger Number :
Snubber Type : ITT 5 X 5
Work Order : 55532263-01
55532463-01 5th 4/2/22

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	6.00/10.00	18.61*	-14.30*
Bleed Rate (ipm)	3.00/5.00	6.42*	-3.81
Test Load (lb)	47,500/52,500	34230*	-44654*

* indicates need for evaluation

VA 90
FA 90
PA 0
PC 2.0

AEP – Cook Plant

- Barker/Diacon Test Stand
- Rated Load 50 Kip
- Anvil 5x5 Fig 201 Configuration A
- Loss of Fluid
- Installed U1C29
- Started leaking ~8 months into life cycle



INDIANA
MICHIGAN
POWER

COOK PLANT

All AEP Property

What happens now?

Source: ISTD 2004 w/2006 Addenda

- ISTD-5312 Additional Sample Size

- When additional samples are required by ISTD-5320, they shall be at least one-half the size of the initial sample from that DTPG.(This

- ISTD-5313 Additional DTPG Sample Composition

- When an unacceptable snubber has not been assigned to an FMG, the additional sample required by ISTD5320 shall be taken from the DTPG. As **practicable**, the additional sample shall include the following:
 - (a) snubbers of the same manufacturer's design
 - (b) snubbers immediately adjacent to those found unacceptable
 - (c) snubbers from the same piping system
 - (d) snubbers from other piping systems that have similar operating conditions such as temperature, humidity, vibration, and radiation
 - (e) snubbers that are previously untested

- ISTD-1800 Supported Component(s) or System Evaluation

- An evaluation shall be performed of the system(s) or components of which an unacceptable snubber is a part, for possible damage to the supported system or component.

Note: This will likely require Design Structural, (or whoever evaluates your piping systems) to do a piping validation and take up limited resources



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Description of Test Bench Acronyms

- VA,FA,PA - Velocity, Force, and Position averaging - A higher number means more averaging when it comes tracing the graph. It's important to note that averaging DOES NOT alter the raw data in the test, this is just to clean up the traces.
- PG, IG - Proportional Gain and Integral Gain - These values dictate how the software is going to handle the load after lockup on a hydraulic snubber test. Essentially proportional gain dictates how quickly the bench is going to try and get up to the desired test load, and integral gain determines how vigilant the bench is going to be at keeping the load in the desired range. Too high a proportional gain may cause you to overload the snubber (if the upper bound on your allowed test load is close to full rated load). When adjusting it, or setting it initially, it's always better to err on the side of having a low value, then creep that number up until the test is getting up to load at a desirable time.
- RR - Ramp Rate - correlates to the acceleration curve during the lockup portion of a hydraulic test. Higher means it will try and lockup the snubber faster. Important to note that this number is essentially a multiplier for a constant in the code, and isn't in any sort of defined unit (so a ramp rate of 2 doesn't mean you'll get a ramp rate that accelerates at 2 ipm/s).
- TT - Test Time - duration of the test. PB - Pressure Boost - is only active during mechanical snubber acceleration tests. It allows the user to increase or decrease the pressure the bench builds before firing off its test, if there is an issue where the benches' automatic pressure calculation for some reason overshoots or undershoots the required load.
- LL - Lockup Limit - The point (as a percent of the rated load of the snubber) at which the computer determines that a snubber has locked up. So when it sees this load during an activation test, the computer will swap from controlling the test via ram velocity and start controlling it via load on the snubber. Low Range - This is sort of outdated language, but it just means which bench is being used. Low Range (load cell) or High range (load cell).



Common Causes – Mechanical

- Mechanical Snubbers
 - Hardened lubrication internal
 - Caused by high Temp
 - Lack of physical movement over time
 - Lack of “exercise”
 - Overloading
 - Lifting points
 - Transients
- Other Failure Mechanisms?



Common Causes – Hydraulic

- Hydraulic Snubbers
 - Loss of Hydraulic Fluid
 - Overloading
 - Vibration
 - Transients
 - Temperature
- Other Failure Mechanisms?



Questions

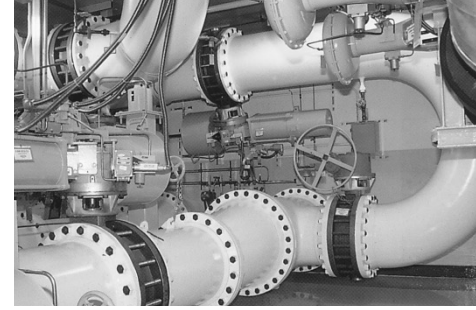
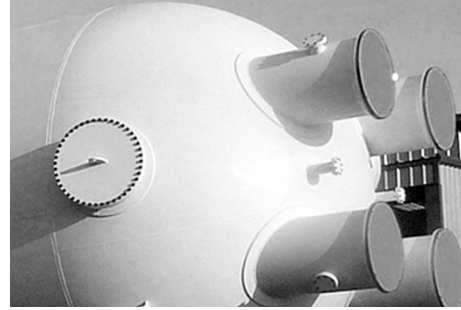
?



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an AEP Company

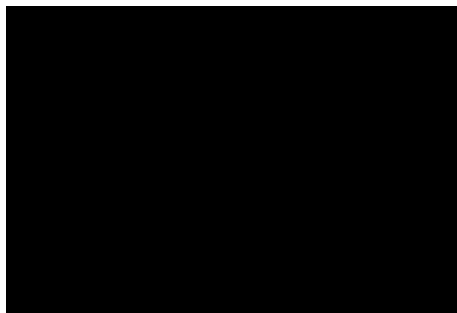


Hydraulic Snubbers – Seal Life and Seal Integrity Testing

Presenter:
Guy Levy, Business Development Manager



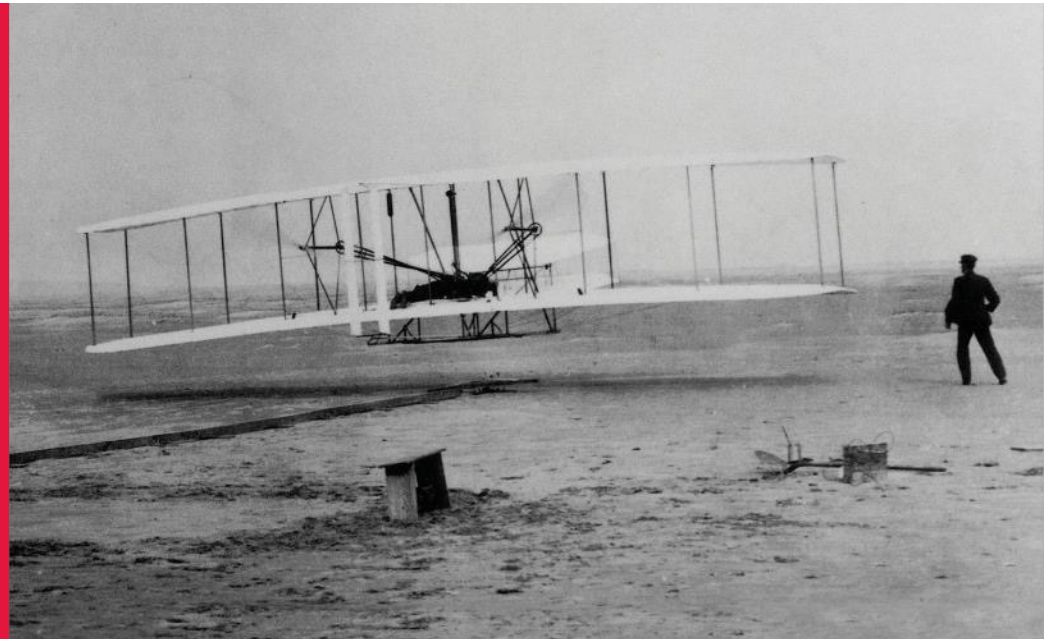
SNUG Conference | Summer 2023



Curtiss-Wright Corporation

PIONEERS OF INNOVATION

Tracing its history back to the First Flight at Kitty Hawk, Curtiss-Wright has evolved into a global organization that provides highly-engineered, mission-critical solutions to the Aerospace & Defense, Power & Process, and General Industrial markets.



Nuclear Legacy



Reactor Coolant Pump
Shippingport PA

Sustainment
EQ, CGD & TPP

Collaboration
Info Services

Optimization
Outage Services

Modernization
Info Technology

Life Extension
Eng. Equipment

New Build
Gen III+ and IV

Supporting the Nuclear Industry Since 1957

EMD

*Farris
Engineering*

EST Group

SCIEN TECH

NETCO

AP Services, LLC

**Target
Rock**

ENERTECH

NOVA

Trentec

QualTech NP

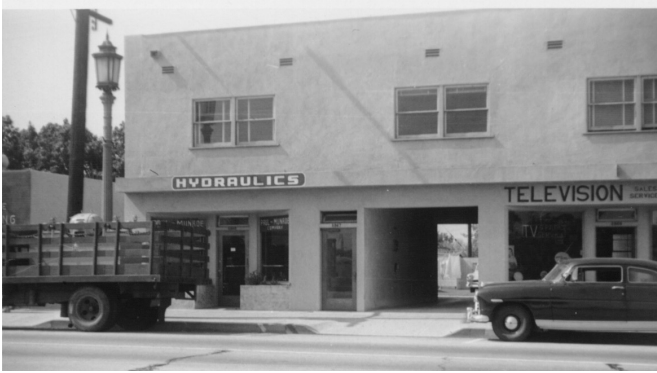
**LMT
TEST**

anatec

>700 Employees **13** Major Facilities

Diversified supplier of safety-critical equipment, technology, and services to the world-wide commercial nuclear power industry

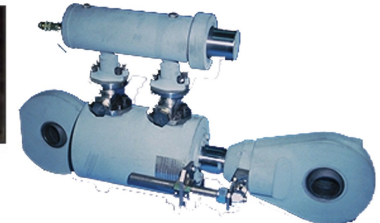
Paul-Munroe Hydraulics Inc.: Enertech's Heritage



1952

- Paul-Munroe Hydraulics Inc.
- California hydraulic distributor, manufacturer
- Enertech established 1967: P-M Energy Products

- Technology-defined company
- Hydraulic snubbers, EHOs
- Bettis distributor



History Timeline



1967- Energy Products
Division- Enertech

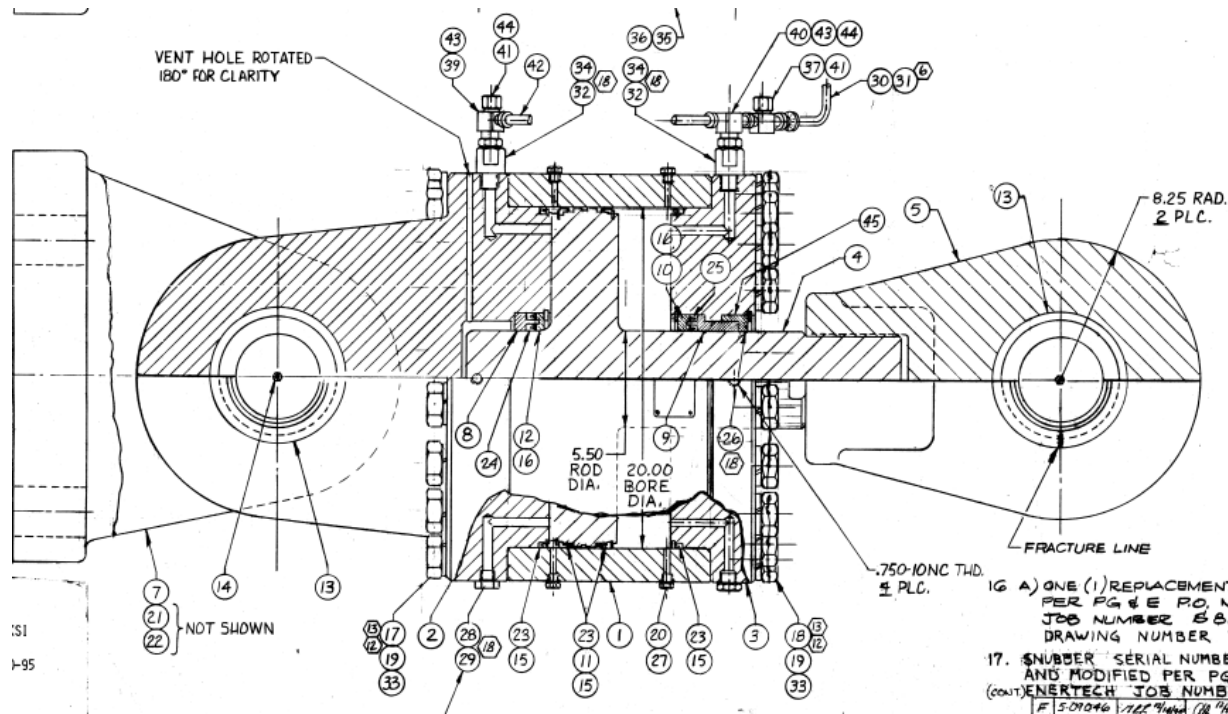


1987-Enertech becomes
independent private
owned corporation

**CURTISS-
WRIGHT**

1998-Curtiss Wright
acquires Enertech

Early Generation Hydraulic Snubber, 1984 (Steam Generator)



16 A) ONE (1) REPLACEMENT PER PG. 4 E P.O. NO. 1700 NUMBER 6801 DRAWING NUMBER P

17. SNUBBER SERIAL NUMBER AND MODIFIED PER PG. 1 (CONT) ENERTECH JOB NUMBER F 5-01046 1/22 9/18/18 1/18

SUPPLIED ENERTECH ASSY		DABLO CANYON SITE UNITS 1&2 PACIFIC GAS & ELECTRIC CO. P.O. NO. 1486005 PMH JOB NO.: 153819N UNIT 2 154814N UNIT 1	
EFURNISHED R 551273,		PUGH QA REVIEW <i>E. Rodriguez 4/14/14</i>	
PAUL-MUNROE HYDRAULICS Engineered Products Group NUCLEAR • MARINE • PROCESS 1701 WEST BEQUOIA, ORANGE, CA 92668		20" BORE • 3" STROKE SNUBBER ASSEMBLY	
DRAWN BY CRB	DATE 2-26-84	SCALE 1/4	CUSTOMER PG&E
CHECKED BY NR	DATE 4-26-84	PEG CODE NO. 12190	
APPROVED BY CRB	DATE 4/1/84	JOB NO. 33819N	
		DRAWING NUMBER PD 3915B	
		ORIGINAL	

REF D-02240 REV B

Presentation Outline

- **Why seals don't last and how to predict expiration date**
- **Why and how to perform snubber seal integrity testing**
- **The (lack of) connection between these two topics**

Why Do Seals Expire?

- The breaking down of bonds in an elastomeric seal is a chemical reaction



- Rate of a chemical reaction depends on temperature
- Arrhenius Equation – the mathematical relationship between reaction rate and temperature

Svante Arrhenius and the Equation



$$k = Ae^{-\frac{E_A}{RT}}$$

Diagram illustrating the Arrhenius equation components:

- k : rate constant
- A : pre-exponential factor
- e : base of natural logarithms
- E_A : activation energy
- R : gas constant
- T : temperature in °K

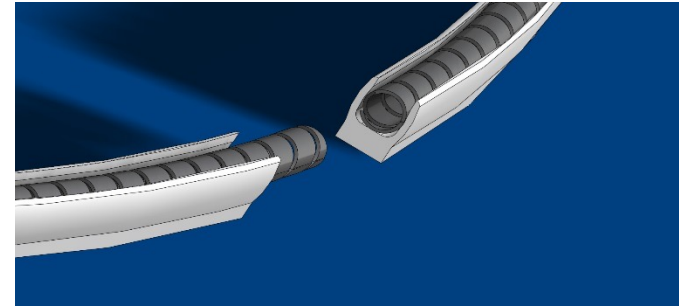
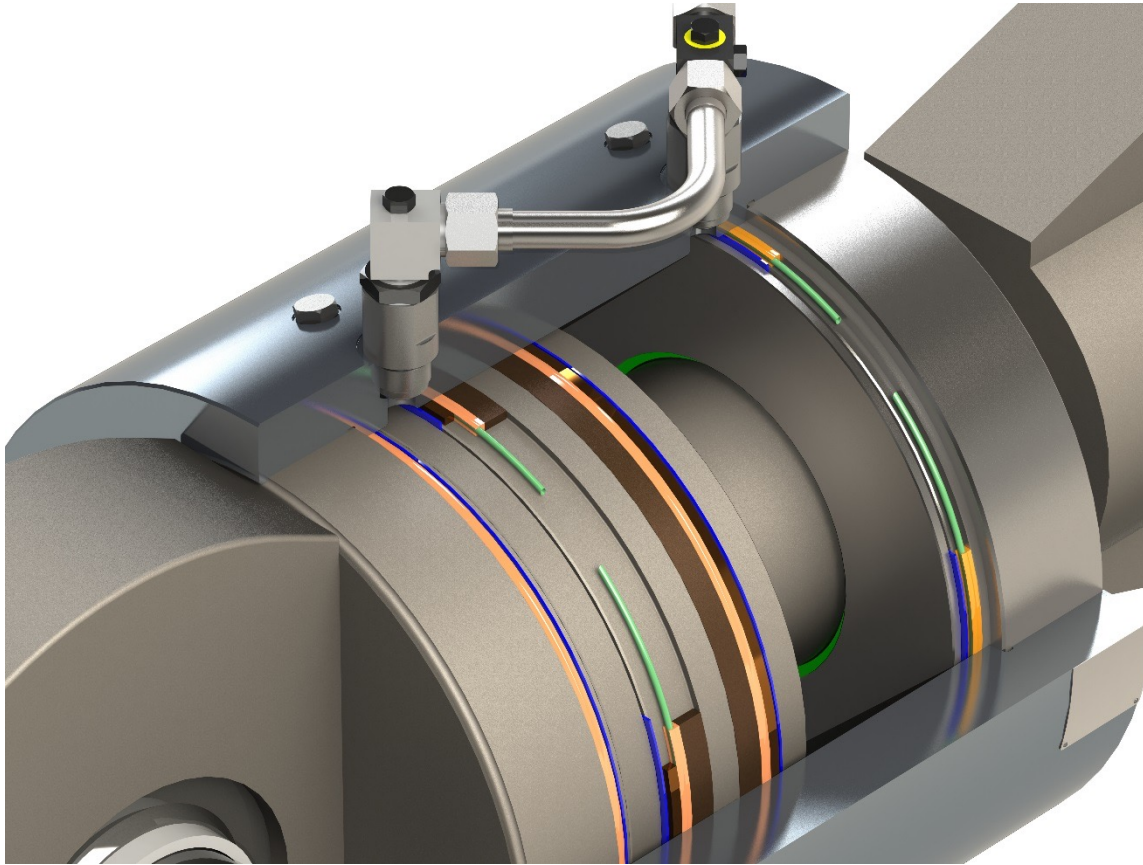
- Reaction rate changes exponentially with temperature
- Activation energy is a material property

Reformatting the Arrhenius Equation

$$T_d = T_i e^{\frac{\phi}{K} \left[\frac{1}{A_t} - \frac{1}{O_{ti}} \right]}$$

- **T_d = Time at High (Accelerated) Temperature**
- **T_i = Operating Lifespan, at Normal Temperature**
- **A_t = Accelerated Temperature, as Tested**
- **O_{ti} = Plant Operating Temperature**

Typical Paul-Munroe Large Capacity Snubber with U-Cup Seals



Paul-Munroe U-Cup Pressure Seal

Thermal Aging Calculation

$$T_d = T_i e^{\frac{\phi}{K} \left[\frac{1}{A_t} - \frac{1}{O_{ti}} \right]}$$

- **Step 1: Select Expected Operating Lifespan**
 - 40 Years - the life of the plant
- **Step 2: Select Max Expected Operating Temperature**
 - 110°F, based on expected max ambient temp
- **Step 3: Calculate Test Duration at High Temperature**
 - 24 days at 250°F
- **Step 4: Test**

Test Results

- **Successful testing - the seals did not degrade beyond failure point**

Tensile strength: -33%

- Elongation: -45%
- Hardness (Shore D): 1.3%
- Compression Set: 37%

- **Conclusion: Acceptable to Operate for 40 Years at 110°F**

- **Note: thermal aging was performed together with radiation aging and cycle + shock testing**
 - 42 Mrads Gamma radiation TID
 - Included Faulted load DBE (2,000,000 lb) test before and after aging

Snubber Functional Post-Qualification Evaluation

- **Changes in Snubber Performance from Qualification**
 - Spring Rate: 13.3% ↑
 - Breakaway Force: - 62% ↓
 - Rod Velocity: -9.2% ↓
- **Changes in SF-1154 Fluid Properties from Qualification**
 - Particulate Weight: 357% ↑
 - Total Acid No: 750% ↑
- **Test results supported 1989 NUREG/CR-5870 Snubber Aging Research Findings of age-related degradation of Snubber installed base**

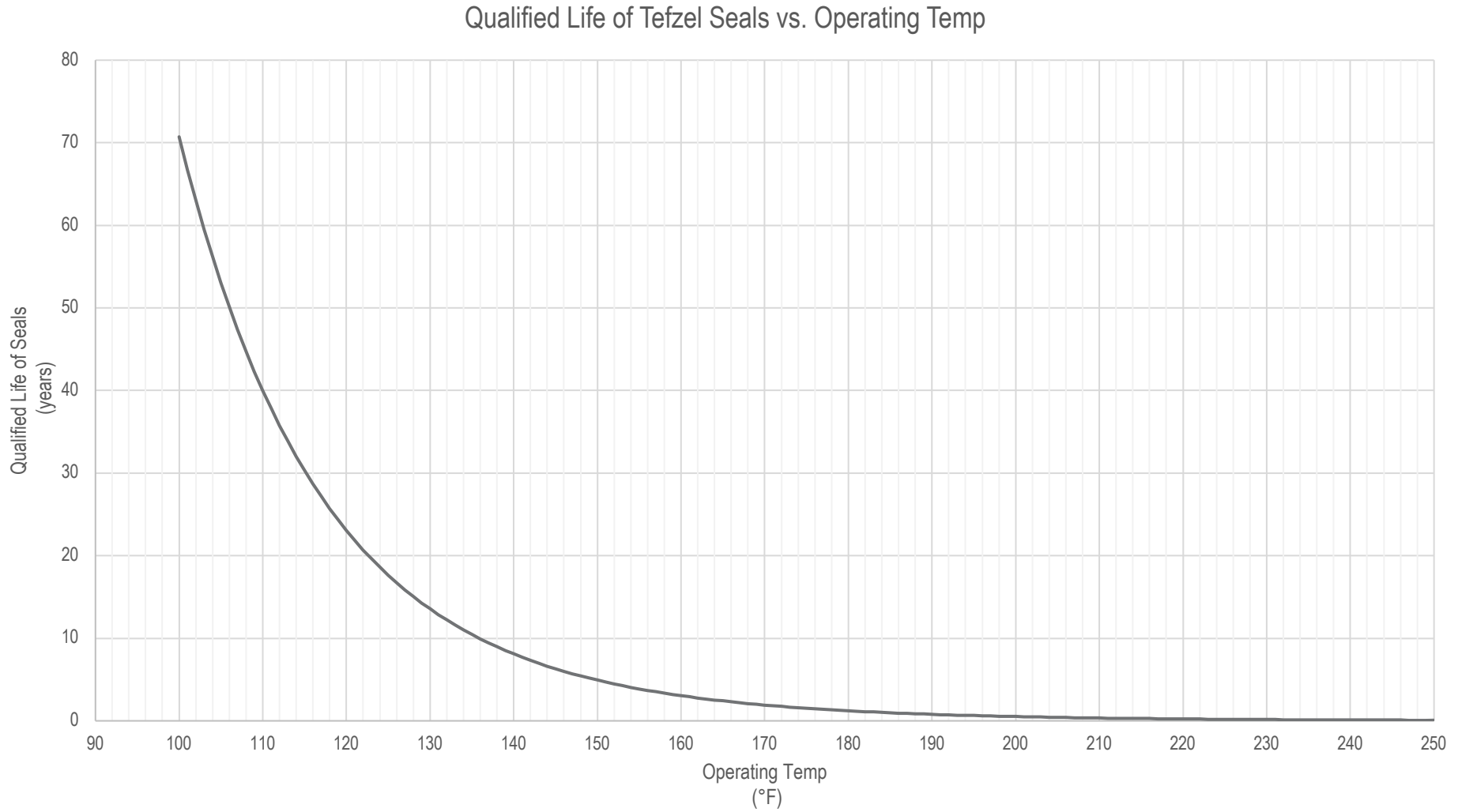
Another Way to Use the Arrhenius Equation

$$T_d = T_i e^{\frac{\phi}{K} \left[\frac{1}{A_t} - \frac{1}{O_{ti}} \right]}$$

Solve for T_i (Qualified Life) as a function of O_{ti} (Operating Temp)

- **T_d = Time at High (Accelerated) Temperature**
- **T_i = Operating Lifespan, at Normal Temperature**
- **A_t = Accelerated Temperature, as Tested**
- **O_{ti} = Operating Temperature**

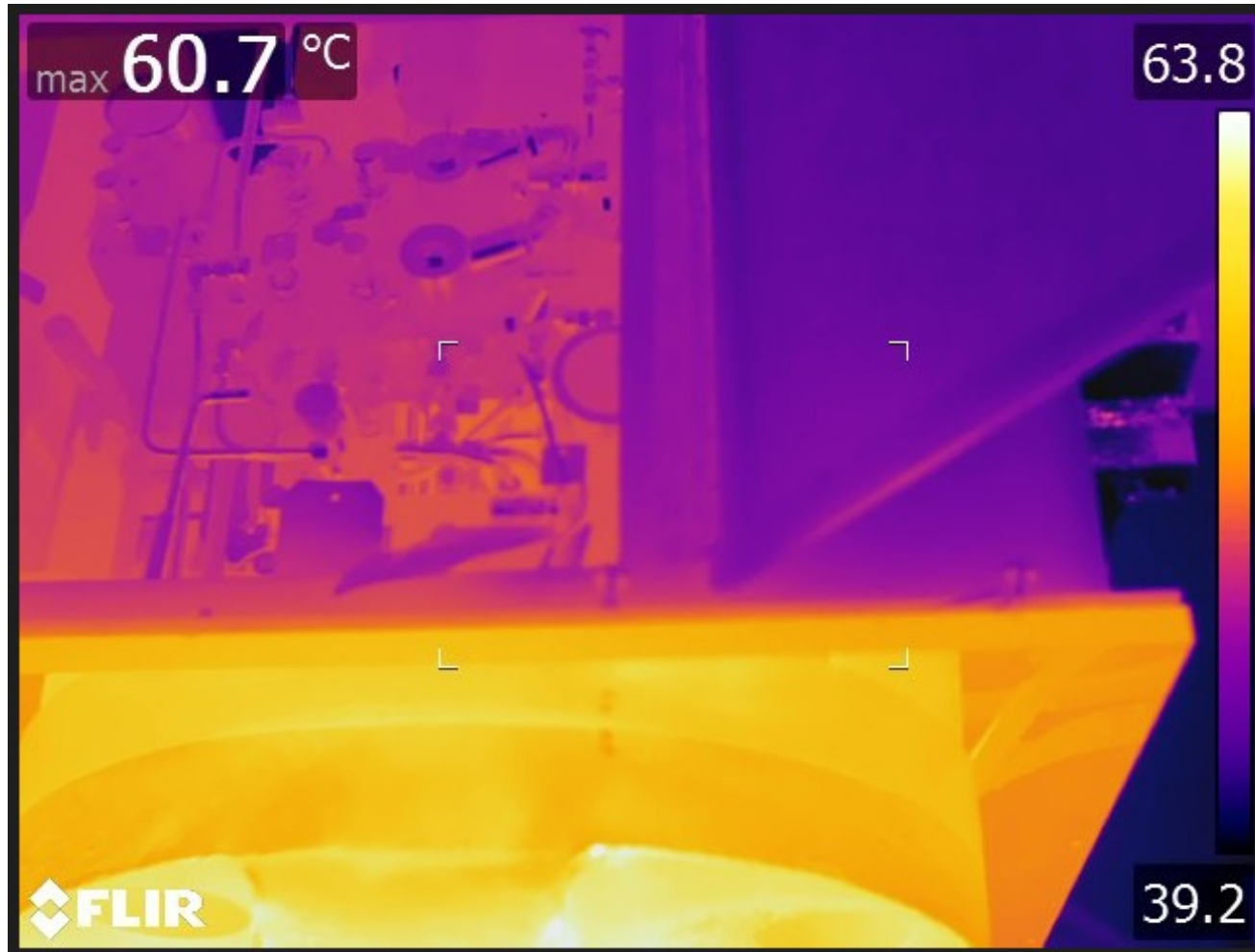
Thermal Aging Curve



Notes On Thermal Aging

- **Not tested to “destruction” – longer duration and/or higher temperature may also have succeeded (adds risk)**
- **Qualified life highly dependent on operating temperature at the position of the seal.**
 - Temperatures during operation are difficult to assess
- **Extending qualified life is not a simple task**
- **Tefzel is qualified for 40 years, other materials such as EPR and Viton generally qualified for just 5 or 10 years**

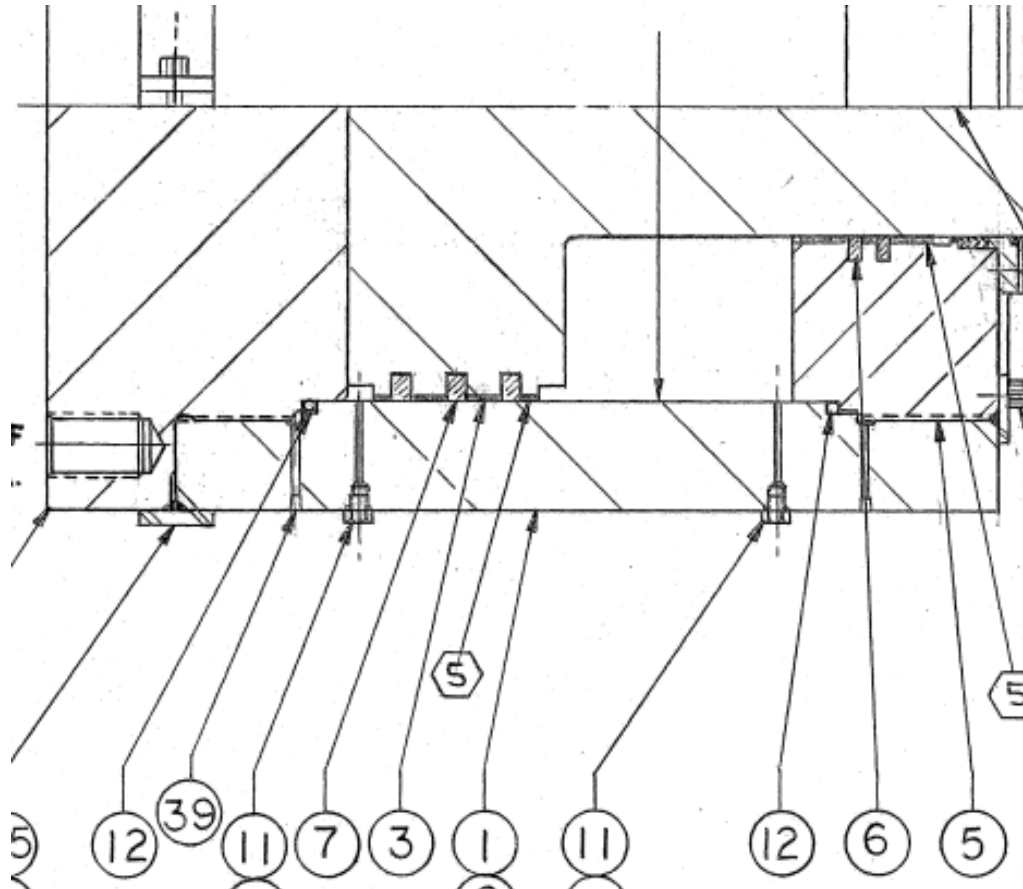
Thermal Camera Image Example



63.8°C = 146°F

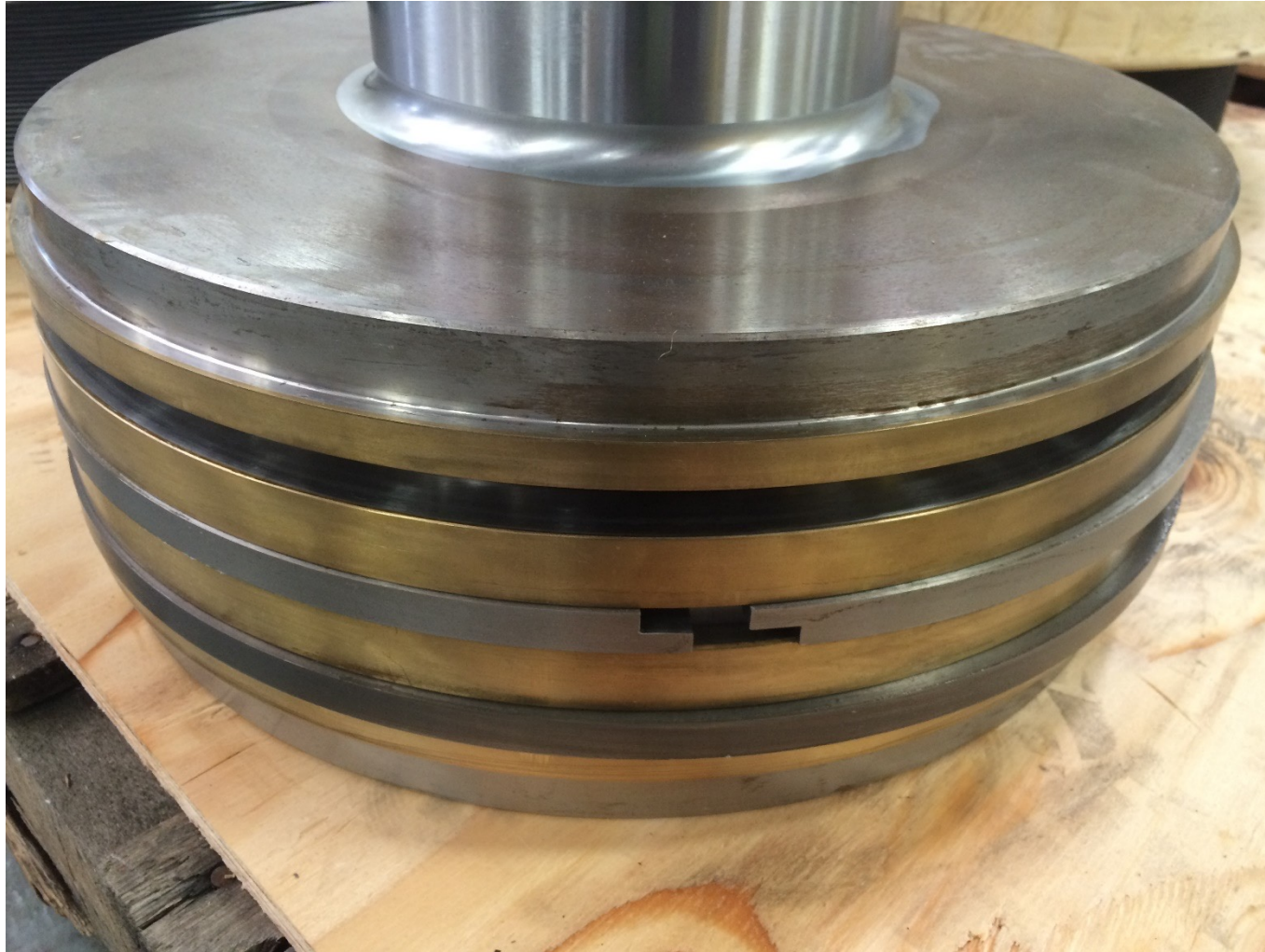
39°C = 102°F

Not All Snubber Seals Expire...



5	PD14316	1	(4) (5)	D-261400	ROD HEAD
6	PA25825	2	IRON	A-701230	ROD RINGS
7	PA25824	3	IRON	A-701229	PISTON RINGS

“Old” Design



- **Vague requirement in ISTD paragraph**

CODE FOR OPERATION AND MAINTENANCE OF
NUCLEAR POWER PLANTS

ASME OM CODE-2004

**ISTD-6400 Additional Monitoring Requirements for
Snubbers That Are Tested Without
Applying a Load to the Snubber Piston
Rod**

The service life evaluation, for hydraulic snubbers that are tested without applying a load to the snubber piston rod, shall consider the results of the following requirements:

(a) monitoring the particulate, viscosity, and moisture content of one or more samples of hydraulic fluid from the main cylinder of the snubber. This may be accomplished using snubbers of the same design in a similar or more severe environment.

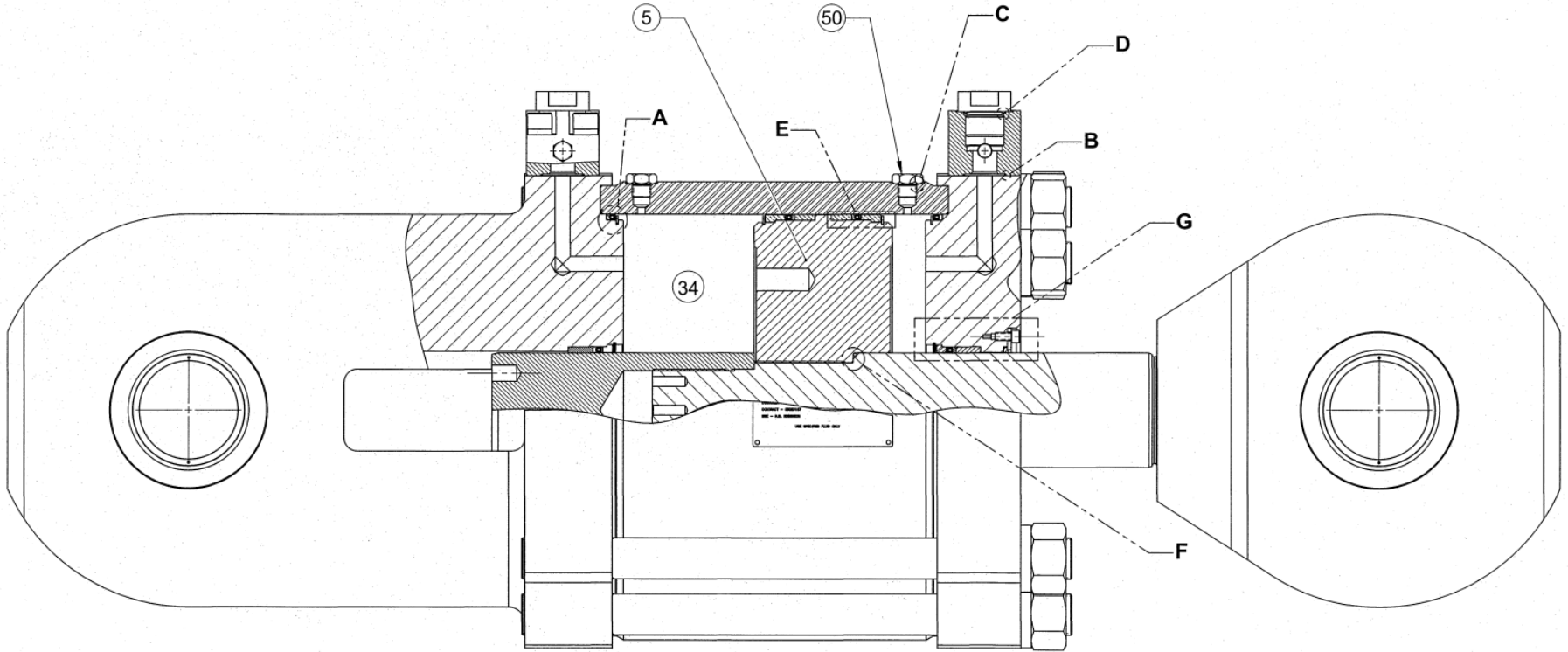
(b) monitoring of piston seal, piston rod seal, and cylinder seal integrity. If seal integrity is monitored by pressurization, pressures less than the snubber's rated load pressure may be used. Minimum pressure allowed shall be specified by the Owner.

**ISTD-6500 Testing for Service Life Monitoring
Purposes**

If testing is conducted specifically for service life monitoring purposes, the results of such testing do not require testing of additional snubbers in accordance with ISTD-5320 or ISTD-5420, but shall be evaluated for appropriate corrective action.

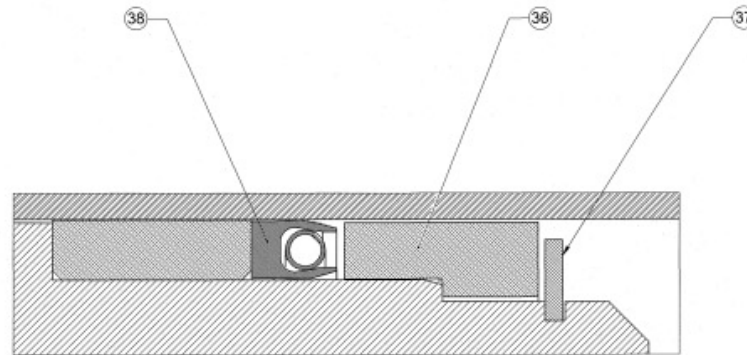
Why do Snubber Seals Matter?

- **Two types – Dynamic Seals and Static Seals**



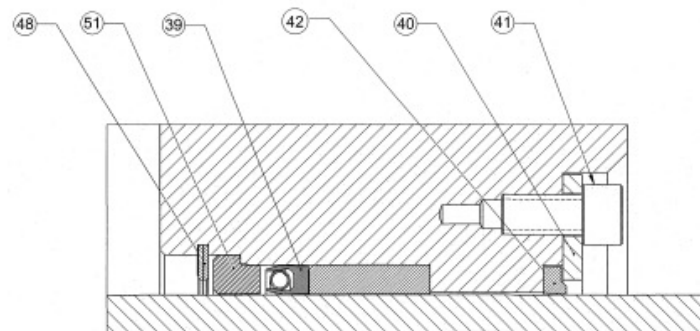
Dynamic Seals

- **Piston and Rod Seals**



DETAIL E

Piston Seal Assembly



DETAIL G

Rod Seal Assembly

Possible Seal Failure Modes

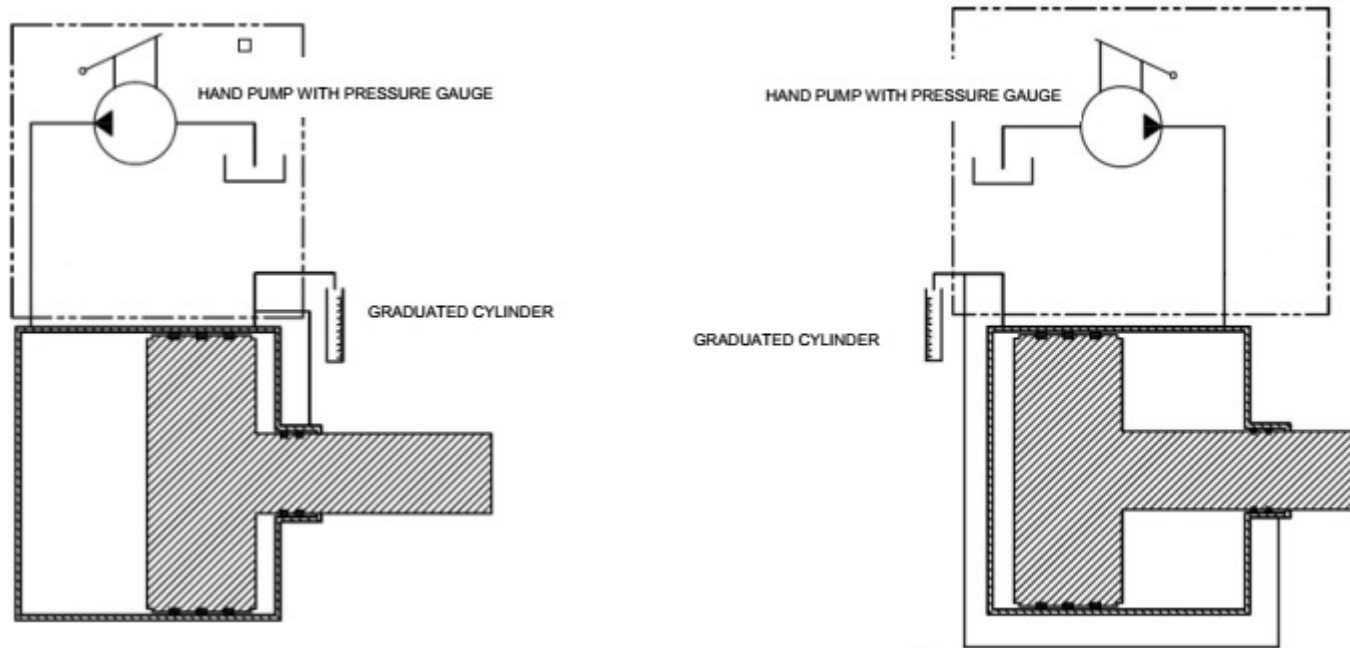
- **Gross piston or rod seal failure may render the snubber inoperable**
 - Fluid may not lock up control valves if allowed past the piston seals (internal) or rod seals (external)
- **Minor piston or rod seal failure may increase lockup/bleed velocity beyond design**
- **Static seal failure may also result in inoperable snubber or increased lockup/bleed velocity**
- **How much seal leakage is acceptable?**
 - Depends on bleed rate (when control valves are locked) – may depend on actual/tested values
 - Uncontrolled seal leakage cannot govern snubber velocity

Testing the Seals Without Removing Snubber

- **Standard test on elastomeric seals:**
 - Apply ~20 psig on either side, monitor pressure decay
 - Cannot exert high pressure/load to snubber piston rod (will damage supported equipment)
 - Default Passing Score: Test Passes at <10% pressure decay over 10 min
 - Second Step: Further calculations based on measured decay
 - Final Step: May measure actual leak rate

Testing Actual Leakage Rate Past Seals

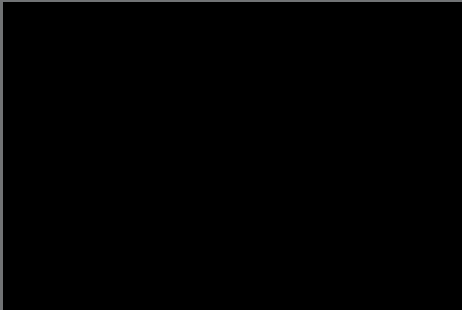
- **Testing metallic seals (iron piston rings):**
 - Apply ~20 psig each side, measure how much leaks by
 - Compare leak rate to as-tested bleed rate/velocity



Thank You!

***CURTISS -
WRIGHT***

Questions?



AFTERNOON BREAK
SPONSORED BY



RETURN BY 3:00 PM



Raw Data File Acquisition & Analysis

Presented by
Jeff Barker (Barker Products) & Nate Potter
(Diacon)

Mike Fromhold (NTS)

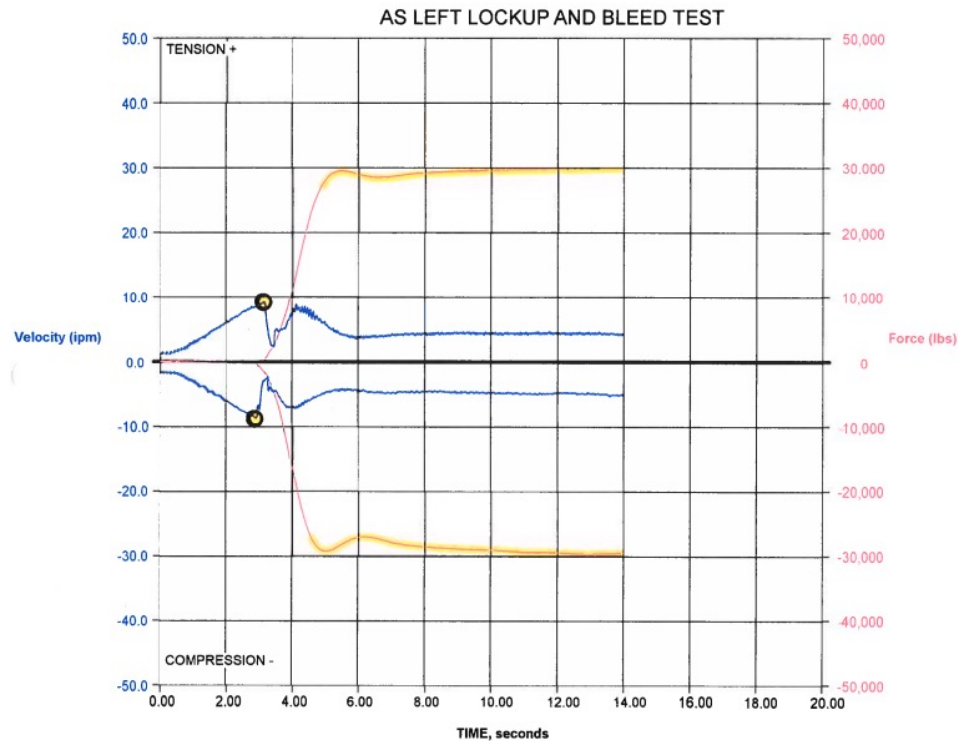
Scott Esposito
Summer 2023 SNUG Conference

Raw Data File Acquisition & Analysis

BERGENPATTERSON (LOCKUP & BLEED)

Test Date : 4/21/2023
Test Time : 10:05:48 AM
Amb Temp: 70 F

Hanger Number : FWU-44
Snubber Type : HSSA 30 GINNA
Work Order : C93825303



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	3.00/20.00	9.23	-8.76
Bleed Rate (ipm)	2.00/20.00	4.38	-4.74
Test Load (lb)	27,000/33,000	29267	-28814

VA 70
FA 70

Raw Data File Acquisition & Analysis

BERGENPATTERSON (LOCKUP & BLEED)

SNUBBER			
IDENTIFICATION	FIELD NAME	ACCEPTANCE CRITERIA	FIELD NAME
HSSA 30 GINNA 30 6	Component ID	2	BAW Drag %FL
	Type	2	Peak Drag %FL
	FL Kip	2	Average Drag %FL
	Stroke	0	Min Accel
ADH 3000 1244 FWU-44	Serial Number	0	Max Accel
	Hanger Number	3	Min Lockup
TEST IDENTIFICATION		20	Max Lockup
FINAL DRAG	Test Type	2	Min Bleed
FALSE	As Found?	20	Max Bleed
GINNA STATION	Test Site	90	Min Test Load
Test Operator	Operator	110	Max Test Load
4/21/2023	Date		
10:25:28 AM	Time		
70	Temperature		
C93825303	Work Request		
	User Comment		

Raw Data File Acquisition & Analysis

BERGENPATTERSON (LOCKUP & BLEED)

MACHINE SETUP

CRITERIA

0	Pressure Boost
3	Prop Gain
1.5	Int Gain
4	Ramp Rate
14	Test Duration
10	Lockup Limit
70	Position Averaging
70	Velocity Averaging
70	Force Averaging
1	Bench (0=small,1=large)
0	Lost Motion Limit
0	Lost Motion Threshold

FIELD NAME

TEST RESULTS

1.427026
6.927026
1.927026
4.427026
200
682
601
85.13268
-2.690113
-178.1651
-8212.025
-630.8383
0
9.227947
4.377984
29266.77
0
-8.758591
-4.742976
-28814.14

FIELD NAME

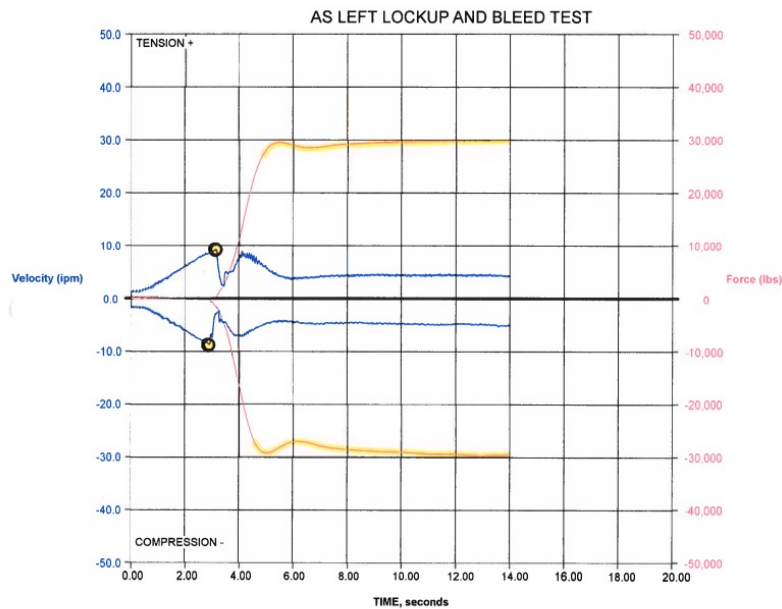
Bottom Out Position
Ext End Position
Retract End Position
Center Stroke Position
Readings per second
Last Compression Reading
Last Tension Reading
Tension BAW
Tension Average
Comp BAW
Comp Average
Comp Peak
Tension Accel
Tension Lockup
Tension BL
Tension Load
Comp Accel
Comp Lockup
Comp BL
Comp Load

Raw Data File Acquisition & Analysis

BERGENPATTERSON (LOCKUP & BLEED)

Test Date : 4/21/2023
Test Time : 10:05:48 AM
Amb Temp: 70 F

Hanger Number : FWU-44
Snubber Type : HSSA 30 GINNA
Work Order : C93825303



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	3.00/20.00	9.23	-8.76
Bleed Rate (ipm)	2.00/20.00	4.38	-4.74
Test Load (lb)	27,000/33,000	29267	-28814

VA 70
FA 70

TENSION DATA					
Position	Velocity	Force	DATA Points		
3.953434	1.254456	60.56661	1	MAX	9.227947
3.951171	1.236008	54.15792	2		
3.951661	1.237852	33.19234	3		
4.182393	8.943949	296.6738	610		
4.184597	8.968912	304.577	611		
4.184254	8.997456	302.785	612		
4.184957	9.050642	306.1082	613		
4.185826	9.102631	305.688	614		
4.186434	9.079989	304.4782	615		
4.188368	9.06783	317.3643	616		
4.188968	9.085146	310.8206	617		
4.189765	9.104646	308.0711	618		
4.192585	8.99654	311.6396	619		
4.192485	9.046311	295.827	620		
4.192792	9.055325	314.055	621		
4.192442	9.09484	313.9973	622		
4.193328	9.111432	318.5345	623		
4.194137	9.130425	313.4708	624		
4.195268	9.165858	318.166	625		
4.195683	9.19804	321.4526	626		
4.196163	9.227947	320.0911	627		
4.199892	9.204607	323.7157	628		
4.19892	9.114477	325.3374	629		
4.199748	9.10673	320.9794	630		
4.200893	9.027515	312.4356	631		
4.201129	8.924101	332.0898	632		
4.202048	8.788988	347.6787	633		
4.20156	8.698098	358.591	634		
4.202727	8.59758	379.047	635		
4.20279	8.446047	402.5214	636		
4.203023	8.347352	418.9536	637		
4.204128	8.256128	438.6958	638		
4.201885	8.133239	463.5016	639		

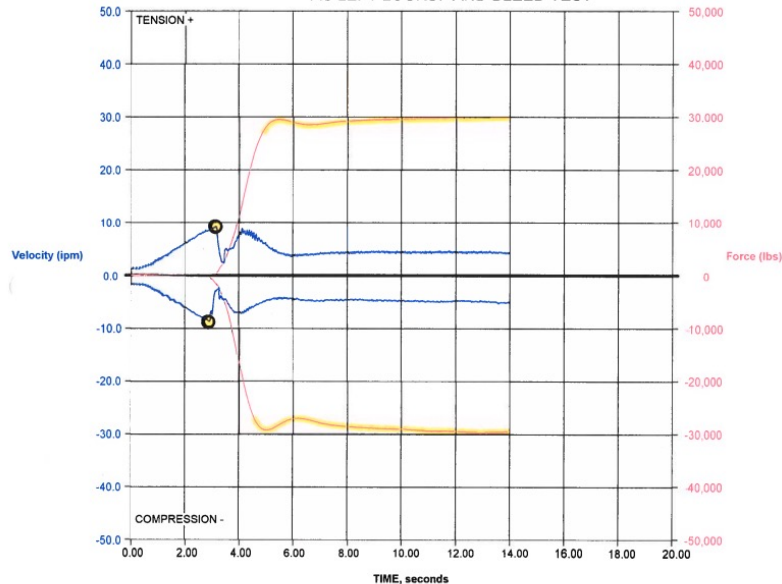
Raw Data File Acquisition & Analysis

BERGENPATTERSON (LOCKUP & BLEED) TEST

Test Date : 4/21/2023
Test Time : 10:05:48 AM
Amb Temp: 70 F

Hanger Number : FWU-44
Snubber Type : HSSA 30 GINNA
Work Order : C93825303

AS LEFT LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	3.00/20.00	9.23	-8.76
Bleed Rate (ipm)	2.00/20.00	4.38	-4.74
Test Load (lb)	27,000/33,000	29267	-28814

VA 70
FA 70

TENSION DATA

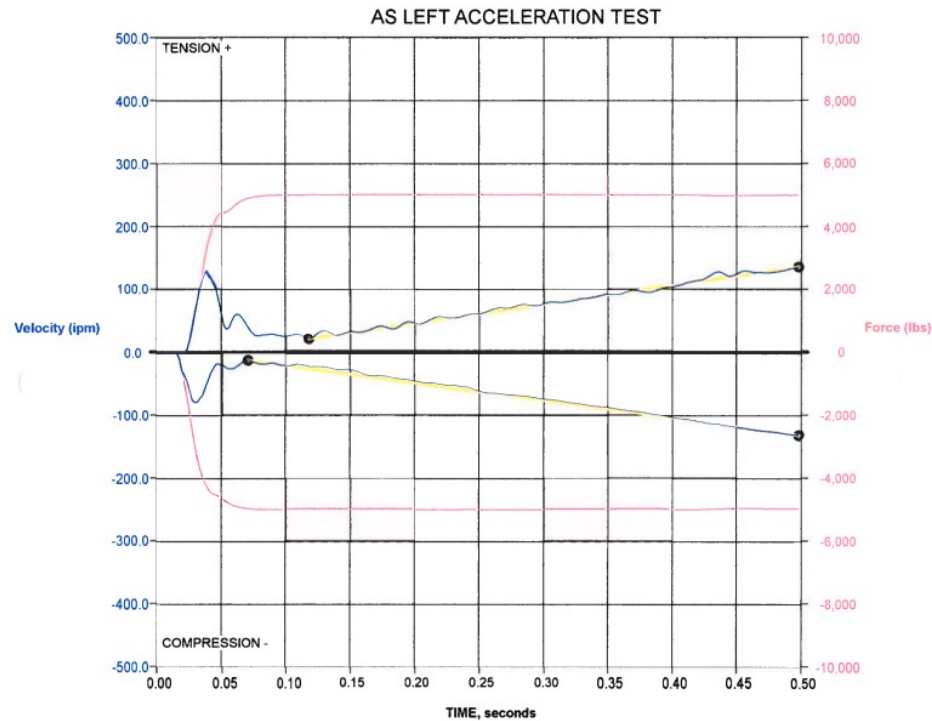
Position	Velocity	Force	DATA Points	
4.377951	6.291334	26891.16	976	
4.378239	6.252411	26937.08	977	
4.378252	6.169821	26980.2	978	
4.378826	6.075113	27025.04	979	Range 27000-33000 lbs
4.380171	6.06416	27065.58	980	
4.379038	6.045425	27091.21	981	
4.379	6.072896	27140.28	982	
4.380104	6.014644	27166.39	983	
4.380877	6.069797	27211.22	984	
4.381795	6.163747	27256.33	985	
4.382061	6.225823	27309.88	986	
4.383001	6.125382	27352.86	987	
4.383471	6.136245	27396.68	988	
4.383799	6.110642	27438.34	989	
4.386669	6.092721	27477.57	990	
4.386981	6.006384	27517.85	991	
4.387387	5.982844	27562.53	992	
4.386729	5.992193	27589.22	993	
4.3874	5.991358	27625.3	994	
4.387681	5.987084	27661.55	995	
4.387877	6.083711	27702.48	996	
4.388581	6.129212	27741.21	997	

Raw Data File Acquisition & Analysis

PSA-3 (ACCELERATION) TEST

Test Date : 4/24/2023
Test Time : 11:37:34 AM
Amb Temp: 70 F

Hanger Number : MSU-82
Snubber Type : PSA 3 GINNA
Work Order : C93909255



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	0.013	-0.012
Test Load (lb)	4,800/6,000	5003	-4997

Raw Data File Acquisition & Analysis

PSA-3 (ACCELERATION) TEST

SNUBBER IDENTIFICATION	FIELD NAME	ACCEPTANCE CRITERIA	FIELD NAME
PSA 3 GINNA	Component ID	0	BAW Drag %FL
6	Type	0	Peak Drag %FL
5	FL Kip	0	Average Drag %FL
45506	Stroke	0	Min Accel
MSU-82	Serial Number	0.02	Max Accel
TEST IDENTIFICATION	Hanger Number	0	Min Lockup
ACCELERATION	Test Type	0	Max Lockup
FALSE	As Found?	0	Min Bleed
GINNA STATION	Test Site	80	Max Bleed
TYLER ZABRUCKY	Operator	100	Min Test Load
4/24/2023	Date		Max Test Load
11:37:34 AM	Time		
70	Temperature		
C93909255	Work Request		
	User Comment		

Raw Data File Acquisition & Analysis

PSA-3 (ACCELERATION) TEST

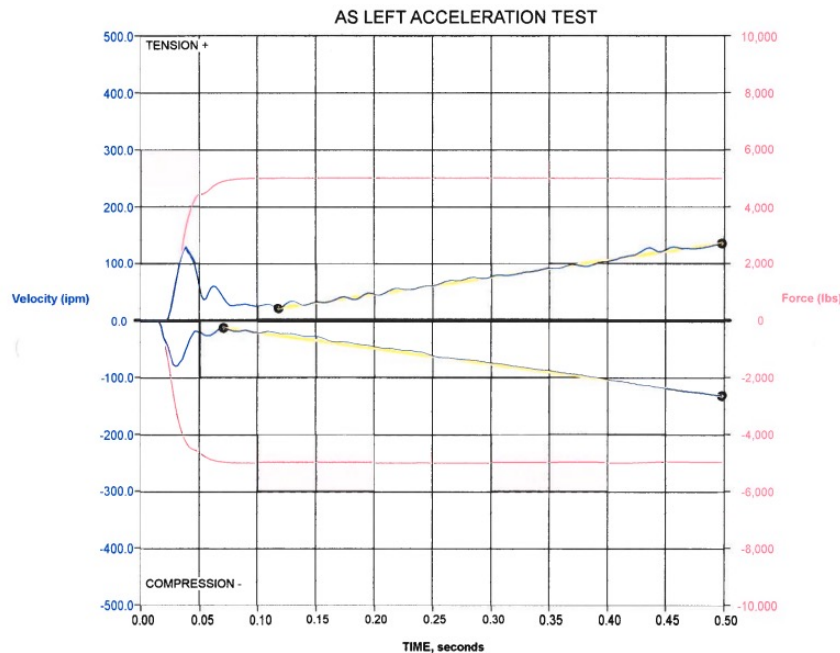
MACHINE SETUP		TEST RESULTS	
CRITERIA	FIELD NAME		FIELD NAME
95	Pressure Boost	4.828818	Bottom Out Position
0	Prop Gain	9.328818	Ext End Position
0	Int Gain	5.328818	Retract End Position
0	Ramp Rate	7.328818	Center Stroke Position
0.5	Test Duration	500	Readings per second
0	Lockup Limit	249	Last Compression Reading
0	Position Averaging	249	Last Tension Reading
90	Velocity Averaging	0	Tension BAW
80	Force Averaging	0	Tension Average
0	Bench (0=small,1=large)	0	Comp BAW
0.03	Lost Motion Limit	0	Comp Average
250	Lost Motion Threshold	0	Comp Peak
		1.30E-02	Tension Accel
		0	Tension Lockup
		0	Tension BL
		5003.033	Tension Load
		-1.19E-02	Comp Accel
		0	Comp Lockup
		0	Comp BL
		-4996.813	Comp Load

Raw Data File Acquisition & Analysis

PSA-3 (ACCELERATION) TEST

Test Date : 4/24/2023
Test Time : 11:37:34 AM
Amb Temp: 70 F

Hanger Number : MSU-82
Snubber Type : PSA 3 GINNA
Work Order : C93909255



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	0.013	-0.012
Test Load (lb)	4,800/6,000	5003	-4997

After achieving 50% of the Max Force selects the Minimum & Maximum Velocity Data Points to calculate the change in velocity over the change in time. This determines the slope of the velocity, and it is then converted to G's.

TENSION DATA					
Position	Velocity	Force	Data Point		
5.334712	3.65E-02	15.85128	1		
5.335341	2.56E-02	15.85128	2		
5.390723	104.3382	2284.628	18		
5.405198	119.4075	2828.309	19	50% Max Force	2501.5165
5.410861	129.0265	3263.254	20		
5.442328	24.99755	5002.204	58		
5.436035	22.56231	5002.37	59		
5.432889	21.21647	5002.503	60	Min Velocity	
5.434147	22.09985	5002.609	61		
5.444846	25.05159	5002.694	62		
5.427854	28.7853	5002.762	63		
5.947056	132.0109	5001.276	247		
5.955238	132.826	5000.956	248		
5.959013	133.8991	4998.503	249		
5.941392	135.499	4995.747	250	Max Velocity	

Raw Data File Acquisition & Analysis

Snubber Number = MSU-82		
	Values	Units
Velocity at the low Point (A)	21.22	ipm
Velocity at the High Point B)	135.5	ipm
Change in Velocity	114.28	ipm
Divided by 720 (convert ipm to ft/sec) = V	0.158722	ft/sec
Time at Data Point (A)	60	500 Readings per sec
Time at Point (B)	250	500 Readings per sec
Change in Time = T	0.38	sec
V divided by T = Acceleration or X	0.41769	ft/sec/sec
X divided by 32.2 = Force Acceleration in g's	0.013	g's

Raw Data File Acquisition & Analysis

LISEGA 3018 (LOCKUP & BLEED) TEST

SNUBBER IDENTIFICATION	FIELD NAME
M1814	Component ID
LISEGA 3018	Type
0.675	FL Kip
4	Stroke
31200256-005	Serial Number
DCA-237-E02-H00	Hanger Number
TEST IDENTIFICATION	
LOCKUP AND BLEED	Test Type
TRUE	As Found?
LIMERICK	Test Site
TEST OPERATOR	Operator
5/6/2023	Date
2:22:41 PM	Time
72	Temperature
5283314-01	Work Request
AS FOUND LI2 R17 TEMP 74.5	User Comment

ACCEPTANCE CRITERIA	FIELD NAME
3	BAW Drag %FL
3	Peak Drag %FL
3	Average Drag %FL
0	Min Accel
0	Max Accel
5	Min Lockup
14	Max Lockup
0.5	Min Bleed
4.5	Max Bleed
85	Min Test Load
100	Max Test Load

Raw Data File Acquisition & Analysis

LISEGA 3018 (LOCKUP & BLEED) TEST

MACHINE SETUP CRITERIA	FIELD NAME
0	Pressure Boost
4.7	Prop Gain
1	Int Gain
4	Ramp Rate
14	Test Duration
25	Lockup Limit
0	Position Averaging
90	Velocity Averaging
90	Force Averaging
0	Bench (0=small,1=large)
0	Lost Motion Limit
0	Lost Motion Threshold

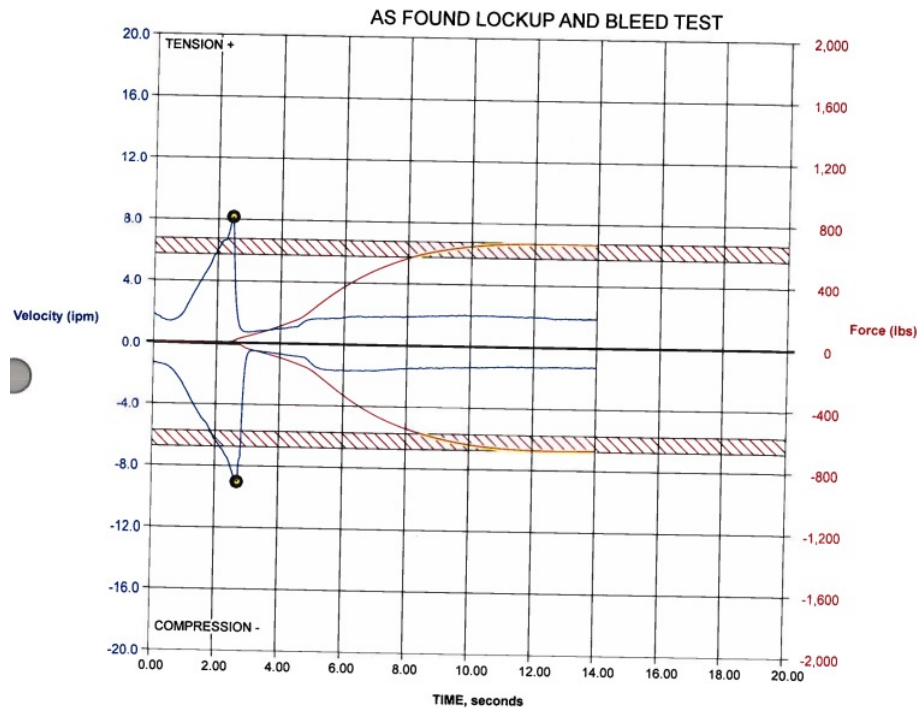
TEST RESULTS	FIELD NAME
1.206783	Bottom Out Position
4.706783	Ext End Position
1.706783	Retract End Position
3.206783	Center Stroke Position
200	Readings per second
2798	Last Compression Reading
2798	Last Tension Reading
2.646681	Tension BAW
2.955233	Tension Average
-7.822392	Tension Peak
-9.000793	Comp BAW
-6.852929	Comp Average
0	Tension Accel
8.166509	Tension Lockup
1.939414	Tension BL
649.6263	Tension Load
0	Comp Accel
-9.026915	Comp Lockup
-1.328656	Comp BL
-651.2868	Comp Load

Raw Data File Acquisition & Analysis

LISEGA 3018 (LOCKUP & BLEED) TEST

Test Date : 5/6/2023
Test Time : 2:22:41 PM
Temperature : 72 F

Serial Number : 01200200-000
Hanger Number : DCA-237-E02-H001
Snubber Type : LISEGA 3018
Work Order : 5283314-01



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	8.17	-9.03
Bleed Rate (ipm)	0.50/4.50	1.94	-1.33
Test Load (lb)	574/675	650	-651

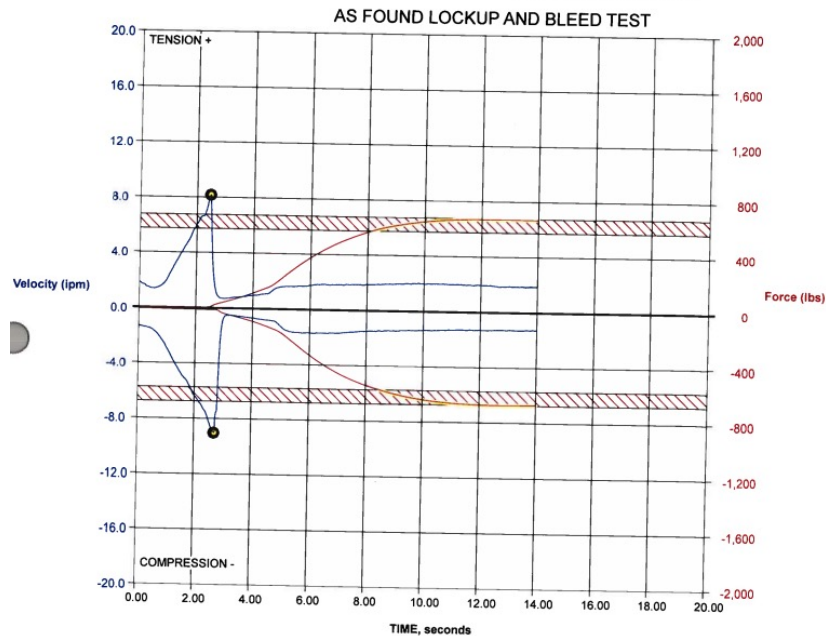
VA 90
FA 90
PA 0

Raw Data File Acquisition & Analysis

LISEGA 3018 (LOCKUP & BLEED) TEST

Test Date : 5/6/2023
Test Time : 2:22:41 PM
Temperature : 72 F

Serial Number : 01209200-000
Hanger Number : DCA-237-E02-H001
Snubber Type : LISEGA 3018
Work Order : 5283314-01



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	8.17	-9.03
Bleed Rate (ipm)	0.50/4.50	1.94	-1.33
Test Load (lb)	574/675	650	-651

VA 90
FA 90
PA 0

TENSION DATA

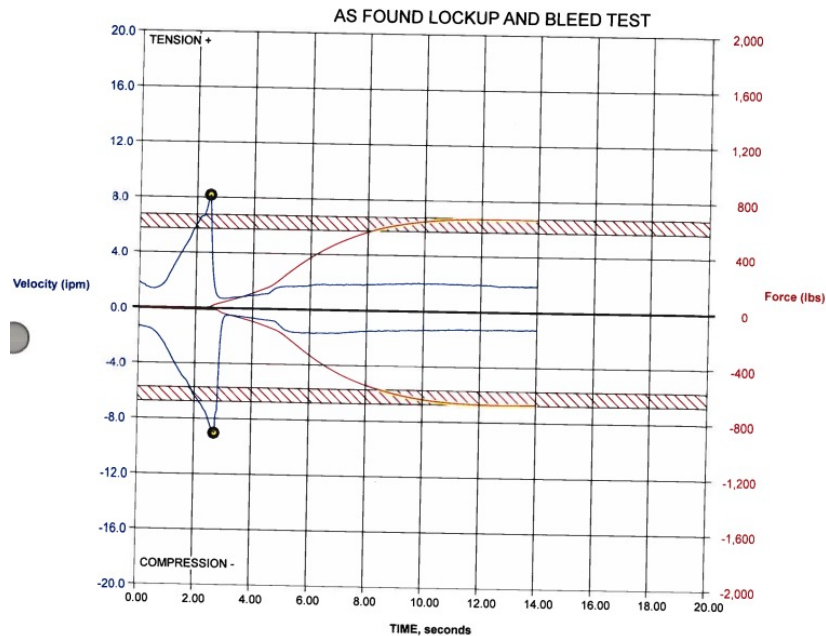
Position	Velocity	Force	
4.254423	7.392452	4.325564	
4.256442	7.4404	4.320253	
4.253077	7.498042	4.339888	
4.257114	7.559578	4.369766	
4.260479	7.622687	4.408864	
4.261152	7.689145	4.419638	
4.259133	7.747991	4.429334	
4.259133	7.799986	4.474682	
4.259133	7.846782	4.491081	
4.261152	7.896625	4.518047	
4.261825	7.94245	4.554523	
4.259806	7.981761	4.575145	
4.262498	8.020038	4.605912	
4.263844	8.049658	4.633602	
4.264517	8.080179	4.621902	
4.26519	8.112478	4.672407	
4.263171	8.139615	4.778897	
4.266535	8.156311	4.801496	
4.269227	8.166509	4.846248	MAX VELOCITY POINT

Raw Data File Acquisition & Analysis

LISEGA 3018 (LOCKUP & BLEED) TEST

Test Date : 5/6/2023
Test Time : 2:22:41 PM
Temperature : 72 F

Serial Number : 01209200-000
Hanger Number : DCA-237-E02-H001
Snubber Type : LISEGA 3018
Work Order : 5283314-01



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	8.17	-9.03
Bleed Rate (ipm)	0.50/4.50	1.94	-1.33
Test Load (lb)	574/675	650	-651

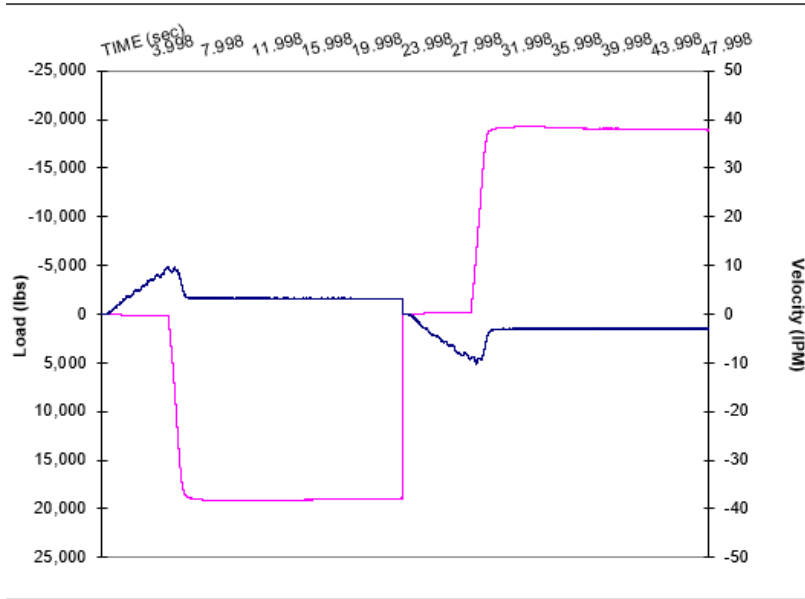
VA 90
FA 90
PA 0

TENSION DATA

Position	Velocity	Force		
4.405833	1.872209	573.5061		
4.406506	1.870438	573.7849		
4.407852	1.869809	574.0724	BLEED	1.939472153
4.407179	1.873107	574.3557		
4.407852	1.871245	574.5861		
4.408525	1.867638	574.9522		
4.408525	1.869221	575.2573		
4.407852	1.870646	575.5441		
4.409198	1.864201	575.8876		
4.409871	1.86323	576.1968		
4.41189	1.864288	576.4263		
4.409871	1.864275	576.7792		
4.409871	1.86233	577.0603		
4.408525	1.874103	577.3132		
4.410543	1.878903	577.5775		
4.41189	1.876462	577.9252		
4.407852	1.881026	578.1893		
4.408525	1.880305	578.4393		
4.410543	1.871928	578.7618		
4.411216	1.869219	579.0644		
4.410543	1.872575	579.3245		

Raw Data File Acquisition & Analysis

Functional Test



Functional Test Results

NTS Model 100 / S.N. 110 - Operator: Test Operator
Wednesday, March 22, 2023 10:25:52

Examination Number: 406
Mark Number: 1E12-H0316
Component Number: 20KIP:718
Snubber Ser. Number: 718
Snubber Type: E-SYSTEM 20 KIP
Rated Load: 20000
Operator Comment: FUNCTIONAL AS FOUND

Work Request Number: 200798482
Cold Set: 0
Service Temp: 0
Ambient Temp: 70

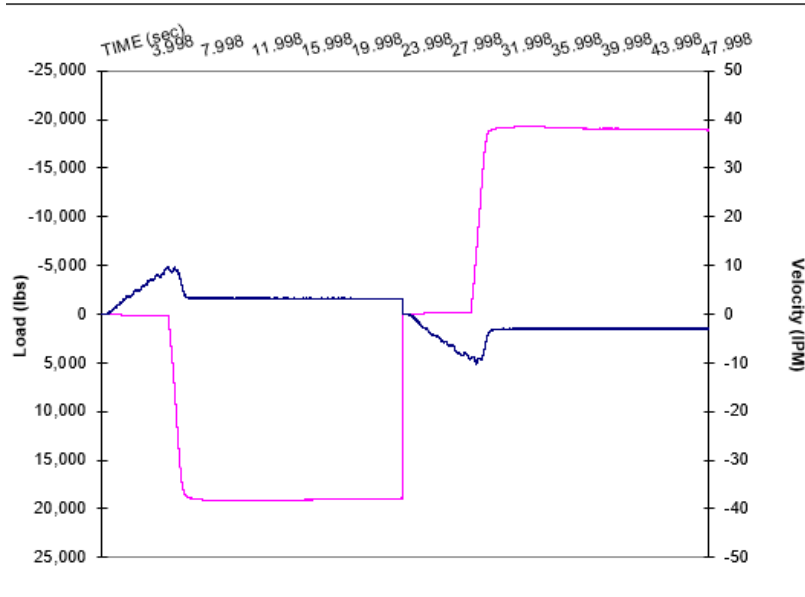
Bleed Rate (Tension) = 3.20 IPM
Lockup Velocity (Tension) = 9.78 IPM
Maximum Load Achieved (Tension) = 19,161.88 lbs. (95.81% of rated load)
Bleed Rate (Compression) = 3.05 IPM
Lockup Velocity (Compression) = 10.31 IPM
Maximum Load Achieved (Compression) = 19,267.74 lbs. (96.34% of rated load)

Acceptable Tension Bleed Rate. (0.5 < IPM < 6)
Acceptable Tension Lockup Velocity. (3 < IPM < 30)
Acceptable Tension Load. (18000 < lbs < 22000)
Acceptable Compression Bleed Rate. (0.5 < IPM < 6)
Acceptable Compression Lockup Velocity. (3 < IPM < 30)
Acceptable Compression Load. (18000 < lbs < 22000)

E-SYSTEMS
20 KIP
(LOCKUP & BLEED) TEST

Raw Data File Acquisition & Analysis

Functional Test



Functional Test Results

NTS Model 100 / S.N. 110 - Operator: Test Operator
Wednesday, March 22, 2023 10:25:52

Examination Number: 406
Mark Number: 1E12-H0316
Component Number: 20KIP:718
Snubber Ser. Number: 718
Snubber Type: E-SYSTEM 20 KIP
Rated Load: 20000
Operator Comment: FUNCTIONAL AS FOUND

Work Request Number: 200798482
Cold Set: 0
Service Temp: 0
Ambient Temp: 70

Bleed Rate (Tension) = 3.20 IPM
Lookup Velocity (Tension) = 9.78 IPM
Maximum Load Achieved (Tension) = 19,161.88 lbs. (95.81% of rated load)
Bleed Rate (Compression) = 3.05 IPM
Lookup Velocity (Compression) = 10.31 IPM
Maximum Load Achieved (Compression) = 19,267.74 lbs. (96.34% of rated load)

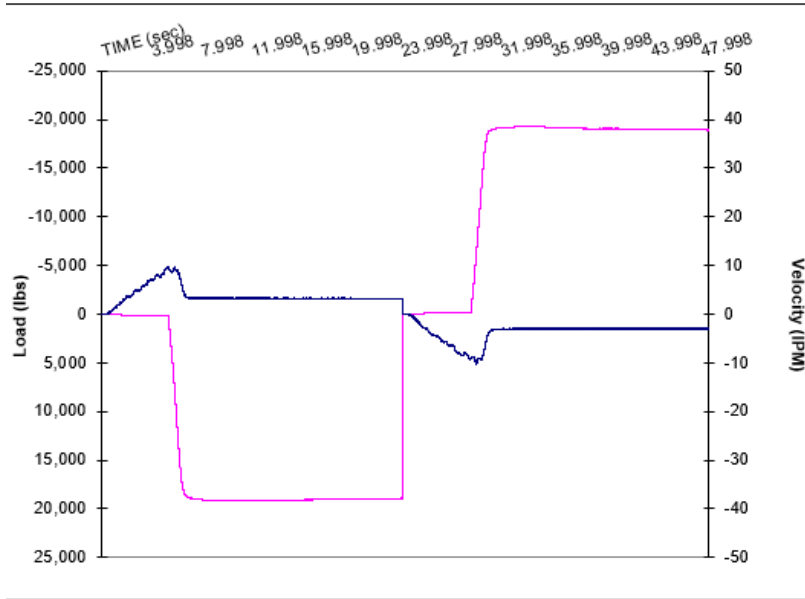
Acceptable Tension Bleed Rate, (0.5< IPM < 6)
Acceptable Tension Lookup Velocity, (3< IPM < 30)
Acceptable Tension Load, (18000<lbs<22000)
Acceptable Compression Bleed Rate, (0.5< IPM < 6)
Acceptable Compression Lookup Velocity, (3< IPM < 30)
Acceptable Compression Load, (18000< lbs < 22000)

E-SYSTEMS 20 KIP (LOCKUP) TEST
Program searches for the highest velocity point

TIME (sec)	VELOCITY (ipm)	LOAD (lbs)	
5.28	9.660	219.632	
5.282	9.680	219.632	
5.284	9.639	218.052	
5.286	9.660	218.052	
5.288	9.639	219.632	
5.29	9.700	218.052	
5.292	9.700	219.632	
5.294	9.781	221.212	MAX VELOCITY
5.296	9.660	219.632	
5.298	9.741	221.212	
5.3	9.700	224.372	
5.302	9.700	219.632	
5.304	9.680	221.212	
5.306	9.660	222.792	
5.308	9.660	219.632	
5.31	9.700	222.792	
5.312	9.639	222.792	
5.314	9.720	224.372	
5.316	9.639	225.952	
5.318	9.700	230.691	

Raw Data File Acquisition & Analysis

Functional Test



Functional Test Results

NTS Model 100 / S.N. 110 - Operator: Test Operator
Wednesday, March 22, 2023 10:25:52

Examination Number: 406

Mark Number: 1E12-H0316

Component Number: 20KIP-718

Snubber Ser. Number: 718

Snubber Type: E-SYSTEM 20 KIP

Rated Load: 20000

Operator Comment: FUNCTIONAL AS FOUND

Work Request Number: 200798482

Cold Set: 0

Service Temp: 0

Ambient Temp: 70

Bleed Rate (Tension) = 3.20 IPM

Lookup Velocity (Tension) = 9.78 IPM

Maximum Load Achieved (Tension) = 19,161.88 lbs. (95.81% of rated load)

Bleed Rate (Compression) = 3.05 IPM

Lookup Velocity (Compression) = 10.31 IPM

Maximum Load Achieved (Compression) = 19,267.74 lbs. (96.34% of rated load)

Acceptable Tension Bleed Rate. (0.5 < IPM < 6)

Acceptable Tension Lookup Velocity. (3 < IPM < 30)

Acceptable Tension Load. (18000 < lbs < 22000)

Acceptable Compression Bleed Rate. (0.5 < IPM < 6)

Acceptable Compression Lookup Velocity. (3 < IPM < 30)

Acceptable Compression Load. (18000 < lbs < 22000)

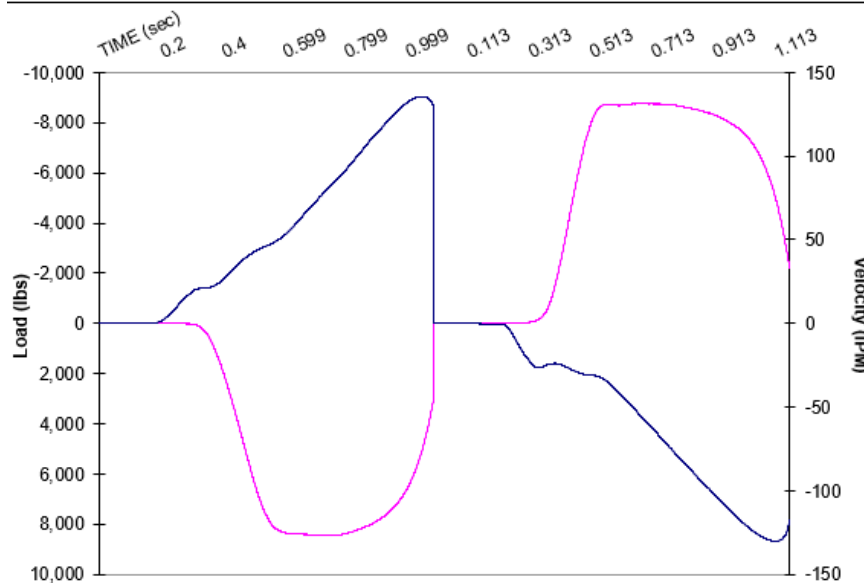
E-SYSTEMS 20 KIP (LOCKUP) TEST

Program averages VELOCITY data points equal to or greater than 18,000lbs and less than or equal to 22,000lbs

TIME (sec)	VELOCITY (ipm)	LOAD (lbs)		
6.498	4.925	17967.440		
6.5	4.885	17980.079		
6.502	4.844	17992.719		
6.504	4.905	18003.779	AVERAGE	3.198
6.506	4.844	18016.419		
6.508	4.844	18025.898		
6.51	4.804	18035.378		
6.512	4.783	18043.278		
6.514	4.783	18054.338		
6.516	4.783	18070.138		
6.518	4.763	18081.197		
6.52	4.661	18090.677		
6.522	4.763	18103.317		
6.524	4.702	18111.217		
6.526	4.682	18120.697		
6.528	4.661	18136.496		
6.53	4.621	18141.236		
6.532	4.641	18150.716		
6.534	4.661	18161.776		
9.126	3.178	19158.737		
9.128	3.117	19160.317		
9.13	3.239	19155.577		
9.132	3.198	19161.897	MAX LOAD	
9.134	3.178	19161.897		
24.09	3.137	18910.682		
24.092	3.097	18910.682		
24.094	3.077	18912.262		
24.096	3.137	18909.102		
24.098	3.077	18909.102		
24.1	3.117	18912.262		

Raw Data File Acquisition & Analysis

Functional Test



Functional Test Results

Wyle Model 150 /S.N. 116 - Operator: Test Operator
Thursday, July 06, 2023 12:39:56

Examination Number: MJF-377 Work Request Number: 7451580
Mark Number: N/A Cold Set: 0
Component Number: MJF377 Service Temp: 0
Snubber Ser. Number: 10643 Ambient Temp: 70.7
Snubber Type: PSA-10
Rated Load: 15000
Operator Comment: FUNCTIONAL AS LEFT

Limiting Acceleration (Tension) = 0.0071 g's
Maximum Load Achieved (Tension) = 8,475.92 lbs. (56.51% of rated load)
Limiting Acceleration (Compression) = 0.0062 g's
Maximum Load Achieved (Compression) = 8,762.30 lbs. (58.42% of rated load)

Acceptable Tension Limiting Acceleration: (0< 0.02)
Acceptable Tension Load: (7500< 10500)
Acceptable Compression Limiting Acceleration: (0< 0.02)
Acceptable Compression Load: (7500< 10500)

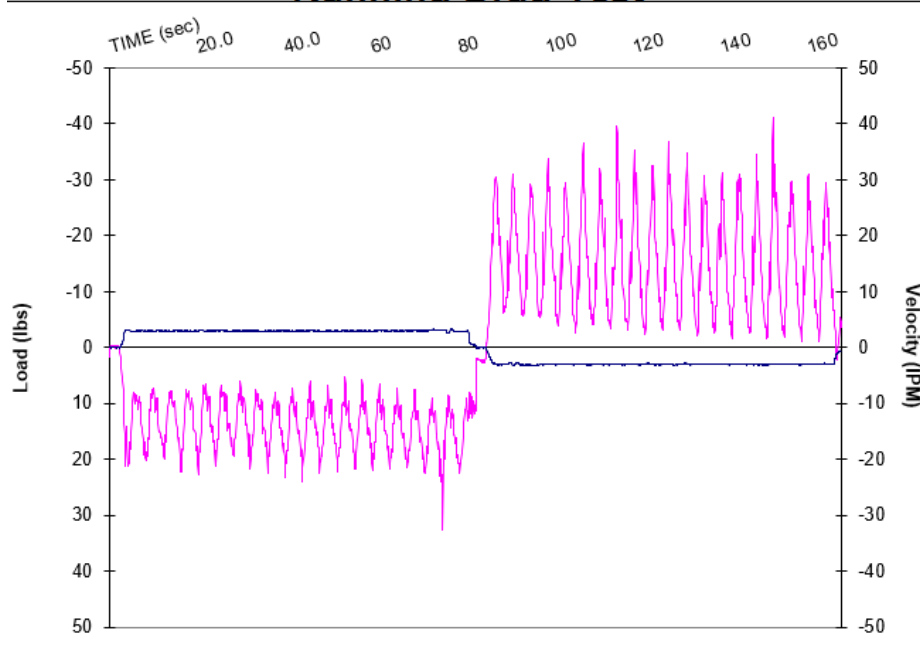
PSA-10 (Acceleration) TEST

Program selects the highest velocity data point and finds the velocity data point 200 milliseconds prior to calculate the change in velocity over the change in time. This determines the slope of the velocity, and it is then converted to G's.

TIME (sec)	VELOCITY (ipm)	LOAD (lbs)	
0.845	100.992	8206.103	
0.846	101.219	8197.967	
0.847	101.466	8201.222	
0.848	101.734	8197.967	
0.849	101.899	8194.713	
0.85	102.167	8180.068	
0.851	102.352	8175.187	
0.852	102.620	8176.814	200 MS PRIOR
0.853	102.867	8171.932	MAX VELOCITY
0.854	103.012	8167.051	
0.855	103.218	8163.797	
0.856	103.486	8155.661	
1.047	135.610	5228.384	
1.048	135.610	5182.824	
1.049	135.589	5145.399	
1.05	135.548	5104.719	
1.051	135.568	5064.040	
1.052	135.630	5024.988	MAX VELOCITY
1.053	135.568	4981.055	
1.054	135.568	4940.375	
1.055	135.568	4886.679	
1.056	135.548	4844.372	
1.057	135.568	4802.066	

Raw Data File Acquisition & Analysis

Running Drag Test



Running Drag Test Results

NTS Model 100 /S.N. 110 - Operator: Test Operator
Tuesday, March 21, 2023 12:29:25

Examination Number: 414	Work Request Number: 200858534
Mark Number: 1E12-H0333	Cold Set: 0
Component Number: PSA3:27498	Service Temp: 0
Snubber Ser. Number: 27498	Ambient Temp: 70
Snubber Type: PSA-3	
Rated Load: 6000	
Operator Comment: RUNNING DRAG (INITIAL) AS FOUND	
Average Drag Force Experienced During Run (Tension) = 13.48 lbs. (0.22%)	
Peak Drag Force Experienced During Run (Tension) = 32.64 lbs. (0.54%)	
Average Drag Force Experienced During Run (Compression) = 16.63 lbs. (0.28%)	
Peak Drag Force Experienced During Run (Compression) = 42.85 lbs. (0.71%)	
Acceptable Tension Average Drag Force. (lbs. < 120)	
Acceptable Tension Peak Drag Force. (lbs. < 120)	
Acceptable Compression Average Drag Force. (lbs. < 120)	
Acceptable Compression Peak Drag Force. (lbs. < 120)	

PSA-3 (DRAG) TEST

- Records the PEAK load value (PINK)
- Averages load data points (PINK)
- Records the velocity (BLUE)
- Load results may not match load values in the raw data due to tare value adjustment

TIME (sec)	VELOCITY (ipm)	LOAD (lbs)	
75.7	3.117	22.885	
75.8	3.117	23.037	
75.9	3.139	20.597	
76	3.182	19.987	
76.1	3.139	22.885	
76.2	3.203	24.105	
76.3	3.139	22.732	
76.4	3.052	28.070	
76.5	3.031	32.645	PEAK DRAG VALUE
76.6	3.160	20.750	
76.7	3.160	16.632	
76.8	3.117	18.157	
76.9	3.160	19.987	
77	3.139	16.784	
77.1	3.117	14.954	
77.2	3.031	13.277	
77.3	2.988	12.057	
77.4	2.815	11.752	
77.5	2.643	10.837	
77.6	2.686	12.362	
77.7	2.643	10.379	
77.8	2.621	8.549	
77.9	2.643	8.854	

Raw Data File Acquisition & Analysis

QUESTIONS?

UNUSUAL TEST PLOTS

Scott Esposito

2023 SUMMER SNUG – Tucson, AZ

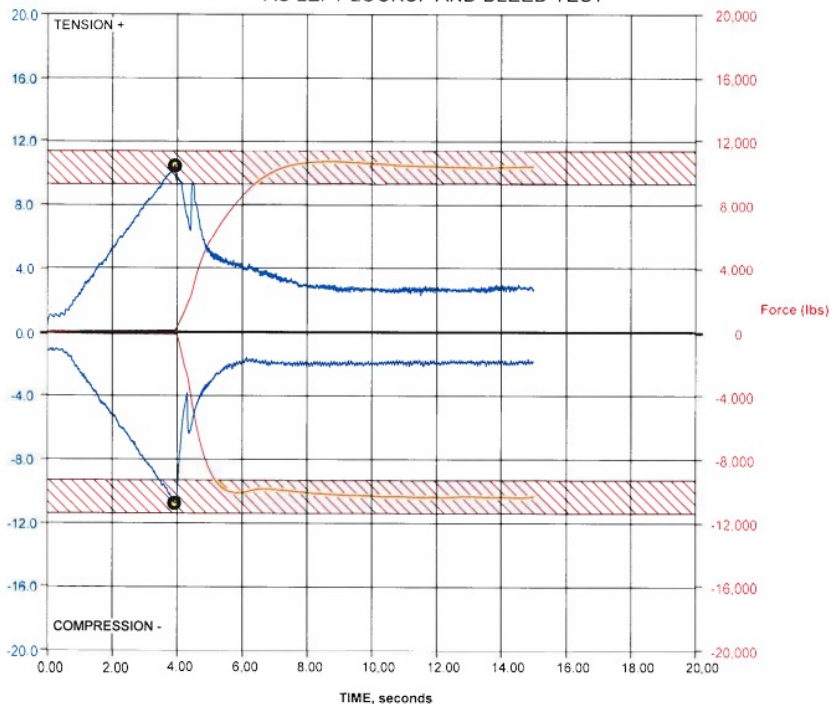
HYDRAULIC SNUBBERS



Test Time : 2:52:08 PM
Temperature : 68 F

Snubber Type : LISEGA 5-10K
Work Order : 4818835 02

AS LEFT LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	10.47	-10.75
Bleed Rate (ipm)	0.50/3.77	2.81	-1.94
Test Load (lb)	9,315/11,385	10401	-10199

VA 80
FA 80
PA 0
PG 1.0
IG 0.60
RR 4.0
TT 15.0
CR 0

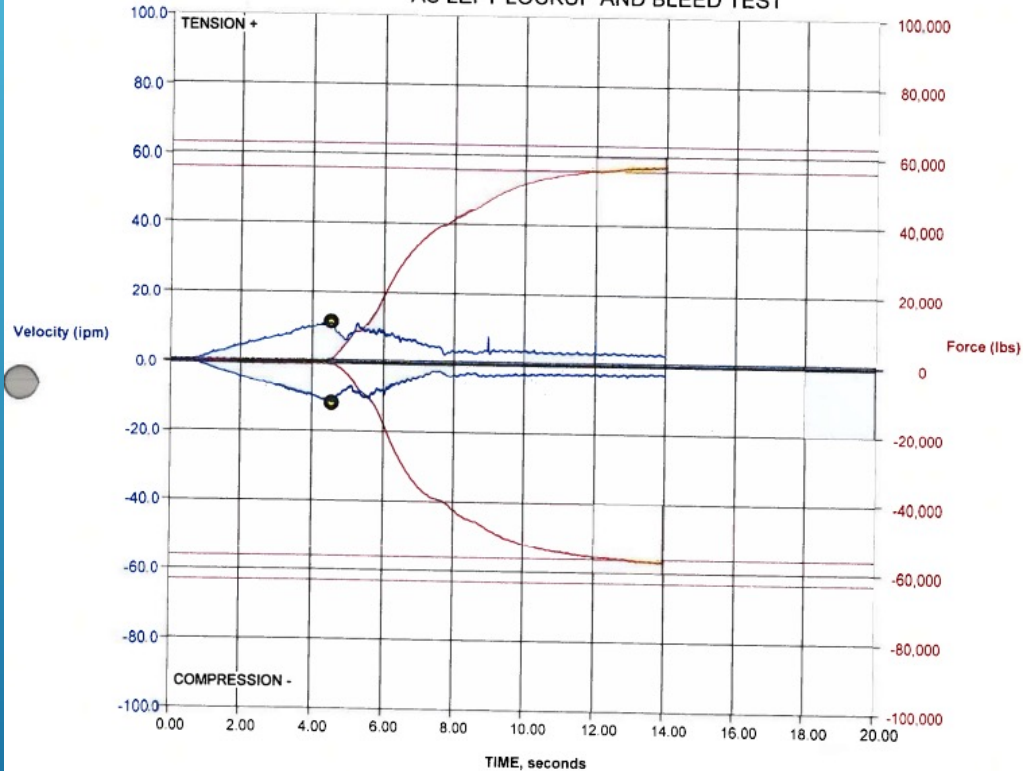
D2R26

Good Lockup & Bleed Test - Lisega

Test Time : 2:43:43 PM
Temperature : 77 F

Hanger Number :
Snubber Type : ES-70 @ 2%
Work Order :

AS LEFT LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	3.00/50.00	11.46	-11.86
Bleed Rate (ipm)	0.50/20.00	3.07	-2.82
Test Load (lb)	56,000/63,000	56,790	-56,451

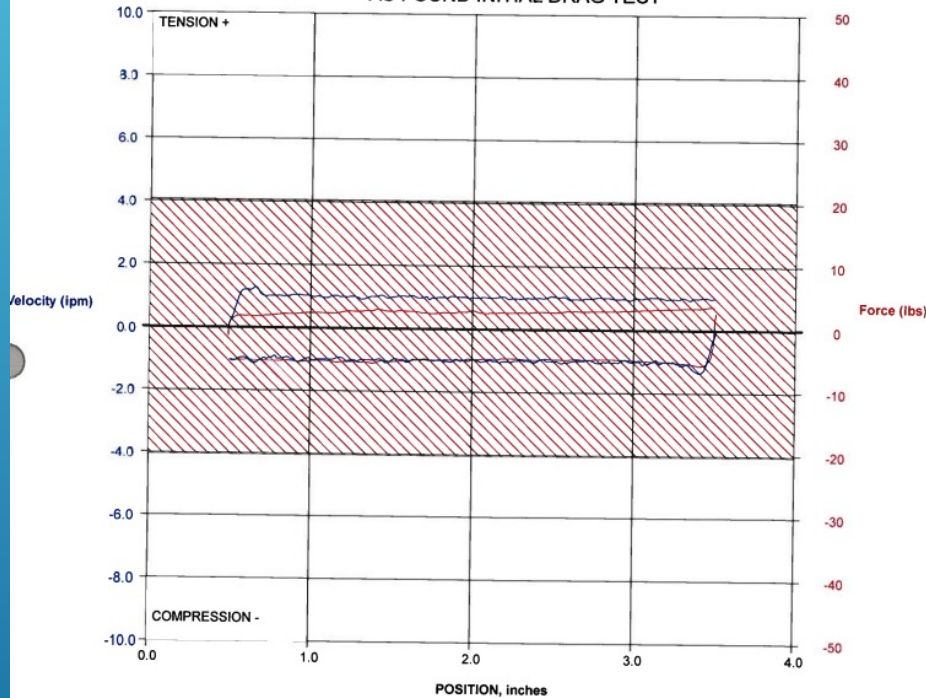
VA 70
FA 70
PA 0
PG 35.0

Good Lockup & Bleed Test - Lisega

Operator : CON HAVENS
 Test Date : 5/6/2023
 Test Time : 2:51:03 PM
 Temperature : 72 F

Serial Number : 31200813-002
 Hanger Number : DCA-238-E02-H00 I
 Snubber Type : LISEGA 3018
 Work Order : 5283315-01

AS FOUND INITIAL DRAG TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Breakaway Load (lb)	0/20.3	1.9	-5.7
Peak Load (lb)	0/20.3	3.7	-5.7
Average Load (lb)	0/20.3	2.3	-4.2

AS FOUND LI2 R17 74 Temp SAT/60

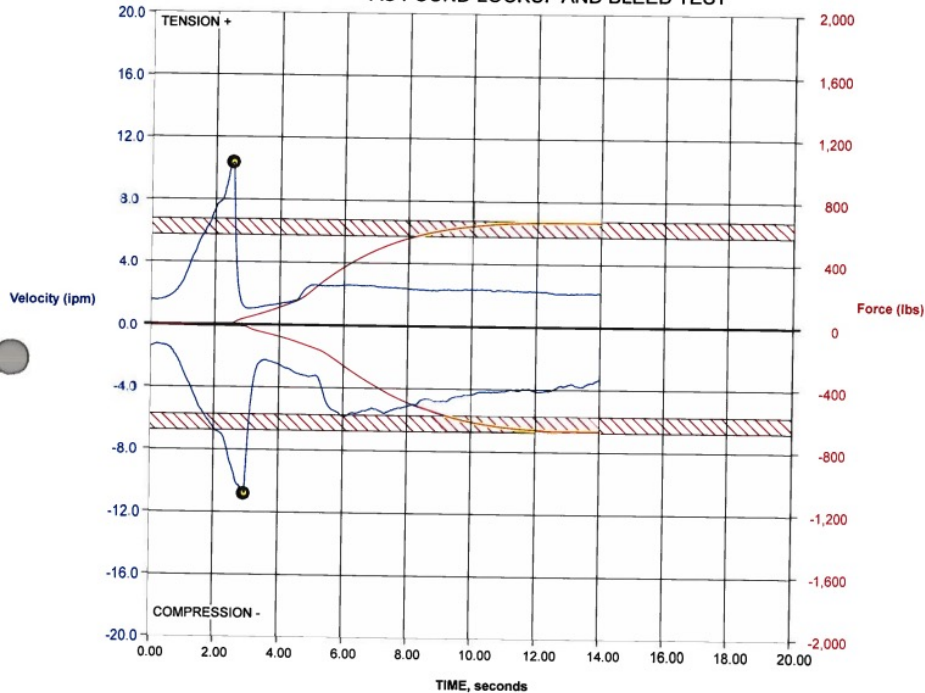
VA 90
 FA 90
 PA 0
 PG 4.7
 IG 1.00
 RR 4.0
 TT 14.0

Good Drag Test - Lisega

Test Date : 5/6/2023
 Test Time : 3:02:00 PM
 Temperature : 72 F

Hanger Number : DCA-238-E02-H001
 Snubber Type : LISEGA 3018
 Work Order : 5283315-01

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	10.38	-10.81
Bleed Rate (ipm)	0.50/4.50	2.28	-4.04
Test Load (lb)	574/675	648	-645

VA 90
 FA 90
 PA 0
 PG 4.7
 IG 1.00
 RR 4.0
 TT 14.0

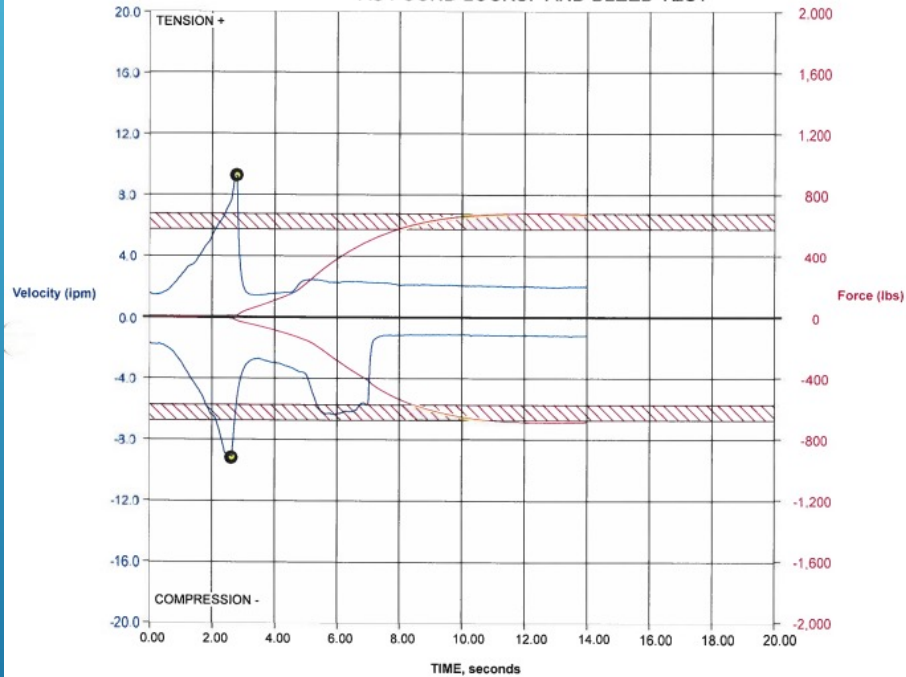
AS FOUND LI2 R17 Temp 74

Unusual Plot - Lisega

Operator : GAW GAW WORK
 Test Date : 5/3/2023
 Test Time : 3:29:32 AM
 Temperature : 72 F

Serial Number : 51200015-007
 Hanger Number : DCA-411-E01-H005
 Snubber Type : LISEGA 3018
 Work Order : 5283320-01

AS FOUND LOCKUP AND BLEED TEST



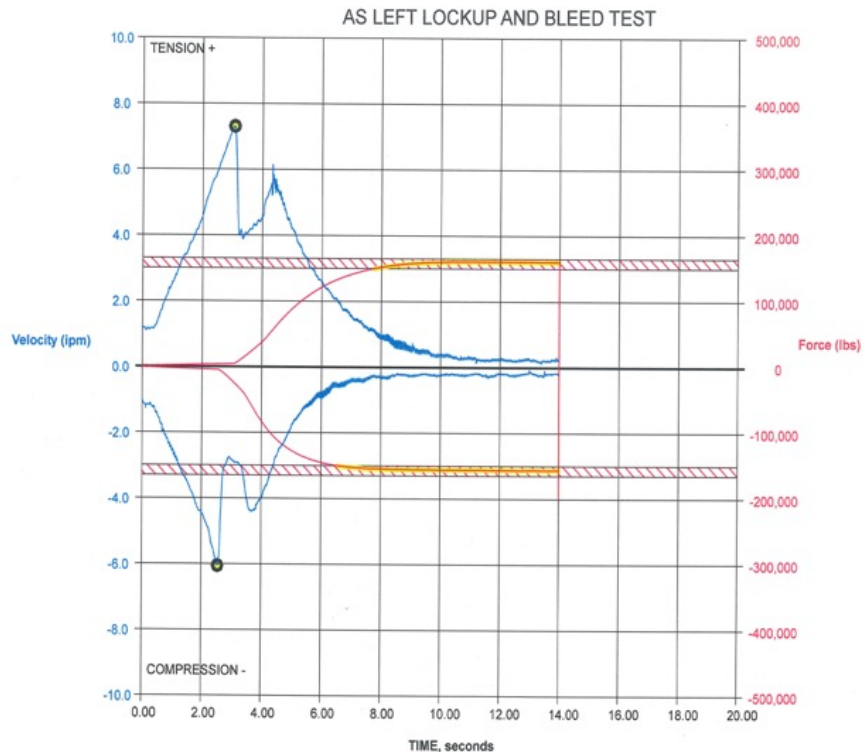
PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	5.00/14.00	9.27	-9.18
Bleed Rate (ipm)	0.50/4.50	2.09	-1.14
Test Load (lb)	574/675	646	-634

VA 90
 FA 90
 PA 0
 PG 4.7
 IG 1.00
 RR 4.0
 TT 14.0
 BR 0

AS FOUND LI2 R17 TEMP 72

Unusual Plot - Lisega

Outside Acceptance Range - Lisega



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	4.60/6.60	7.31*	-6.05
Bleed Rate (ipm)	0.01/0.38	0.40*	-0.26
Test Load (lb)	150,000/165,000	159224	-155215

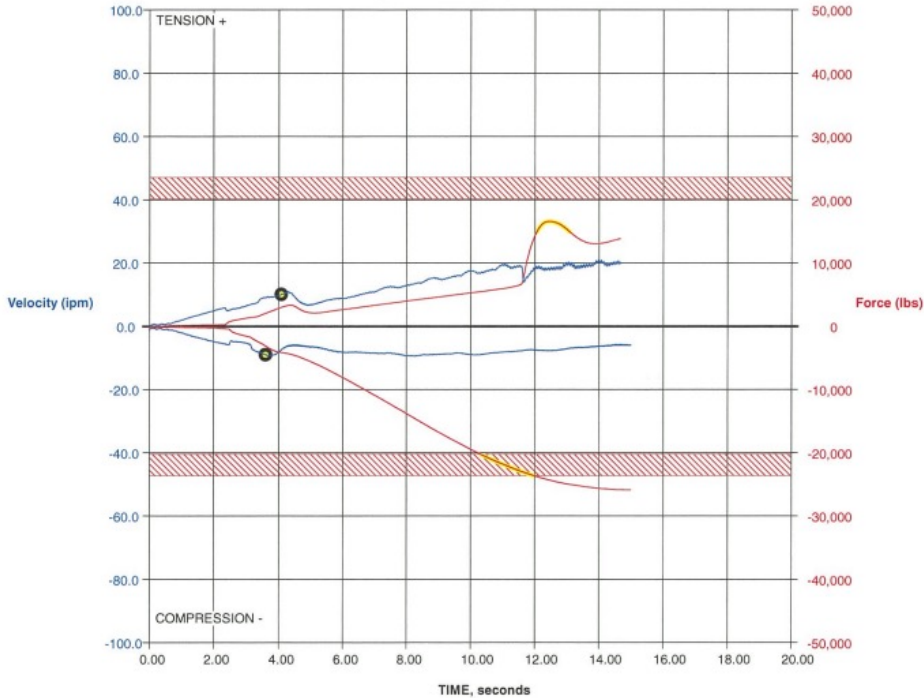
* indicates need for evaluation

VA 90
FA 0
PA 0
PG 3.0
IG 0.50
RR 1.0

Test Date : 3/28/2023
Test Time : 8:52:05 AM
Temperature : 66 F

Hanger Number : 1-3001-C71
Snubber Type : 3062 (22.45K)
Work Order : 04970216-04

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	4.72/50.00	10.13	-8.97
Bleed Rate (ipm)	0.47/4.72	18.65*	-8.00*
Test Load (lb)	20,205/23,573	16103*	-22009

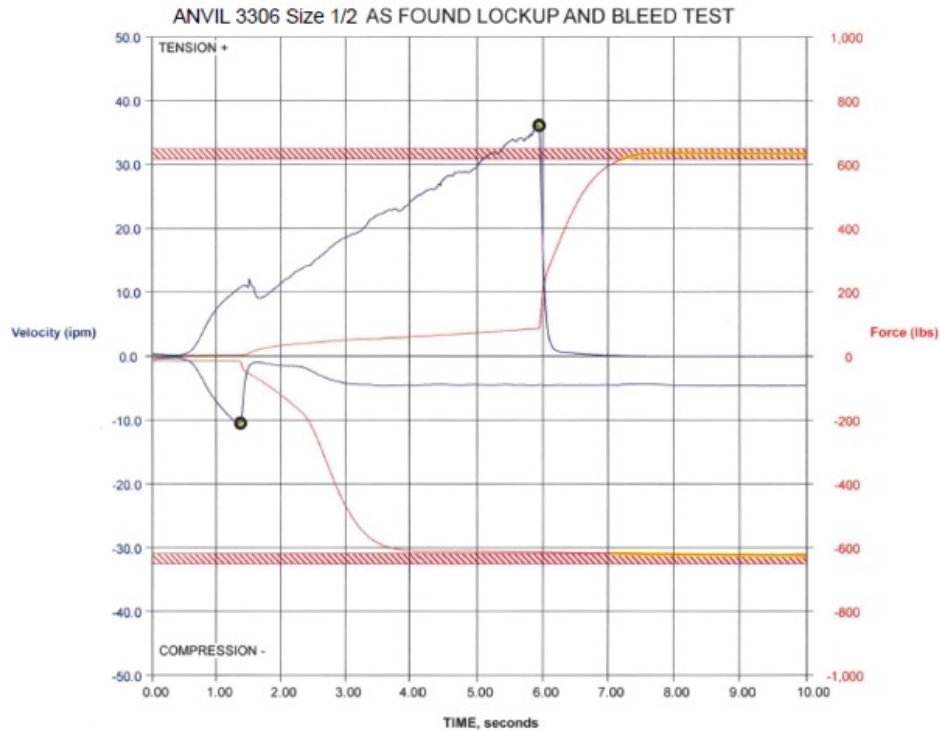
* indicates need for evaluation

VA 80
FA 80
PA 0
PG 1.0
IG 0.60
RR 4.0
TT 15.0
PB 0

DTPG-1

Outside Acceptance Range - Lisega

Outside Acceptance Range - ASC 3306

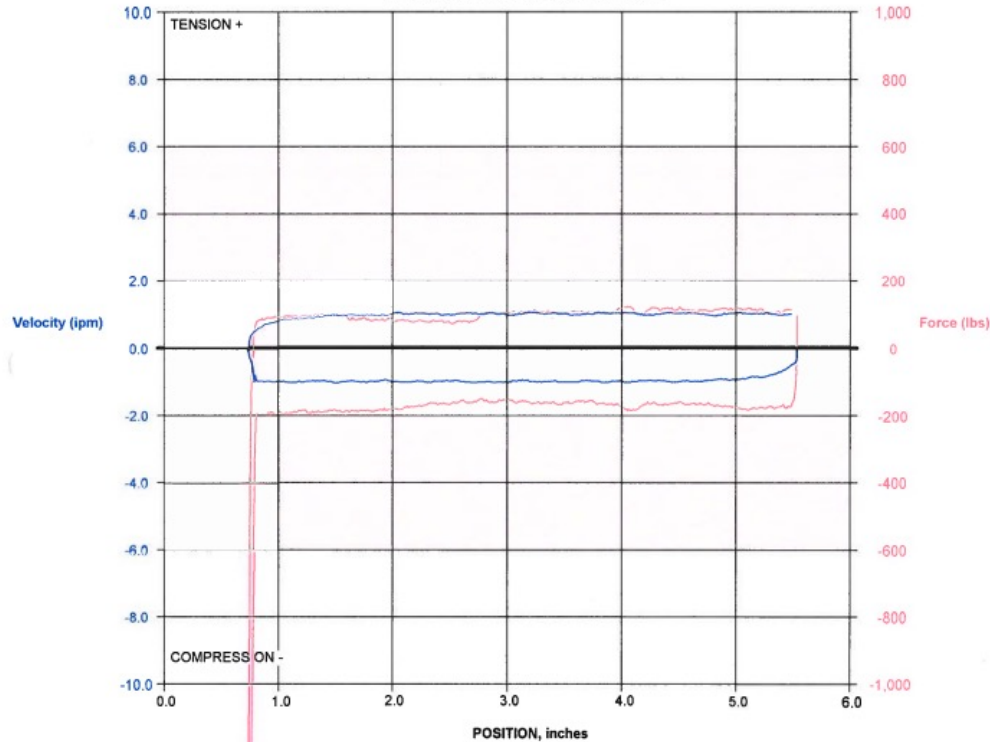


PARAMETER	TENSION	COMPRESSION
Lockup Rate (ipm)	36.13	-10.48
Bleed Rate (ipm)	0.02*	-4.51
Test Load (lb)	633	-621

Test Date : 4/21/2023
Test Time : 10:25:28 AM
Amb Temp: 70 F

Hanger Number : FWU-44
Snubber Type : HSSA 30 GINNA
Work Order : C93825303

AS LEFT FINAL DRAG TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Breakaway Load (lb)	0/600.0	85.1	-178.2
Peak Load (lb)	0/600.0	121.0	-8212.0*
Average Load (lb)	0/600.0	-2.7*	-630.8*

* indicates need for evaluation

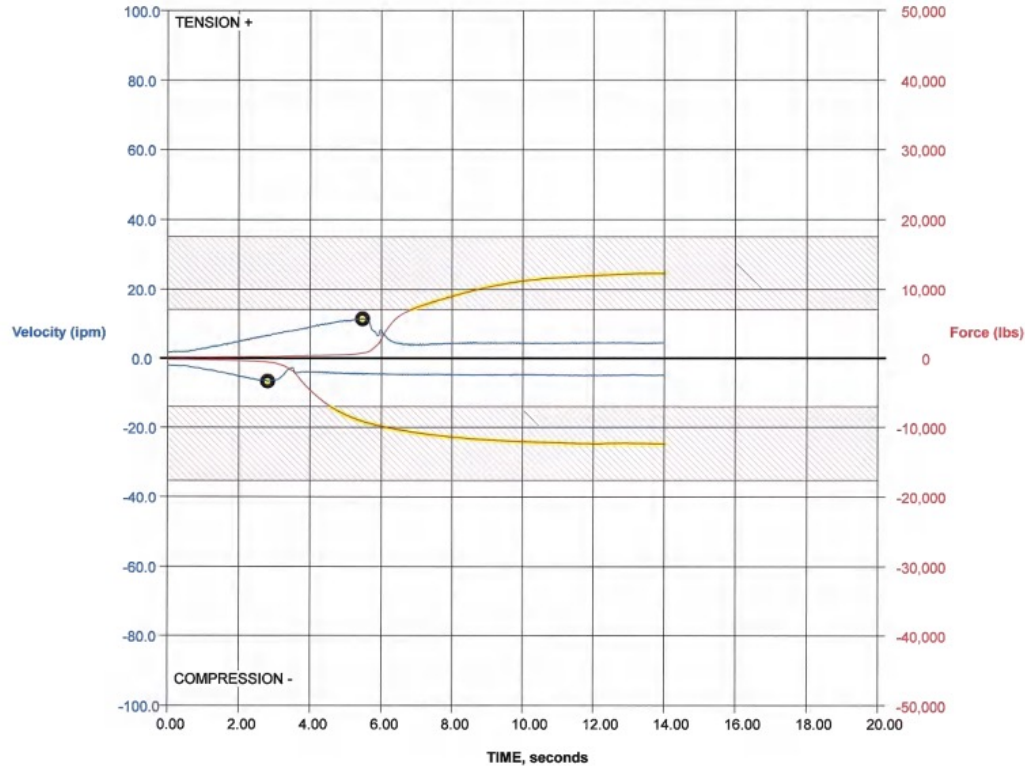
VA 70
FA 70
PA 70
PG 3.0
IG 1.50

Unusual Plot – Bergen-Paterson

Test Date : 3/19/2023
Test Time : 11:09:51 AM
Amb Temp: 72 F

Hanger Number : 2-FDH-244L
Snubber Type : BE 3-1/4
Work Order : 121952346

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	0.75/80.00	11.47	-6.71
Bleed Rate (ipm)	0.75/15.00	4.40	-4.78
Test Load (lb)	7,040/17,600	10848	-11279

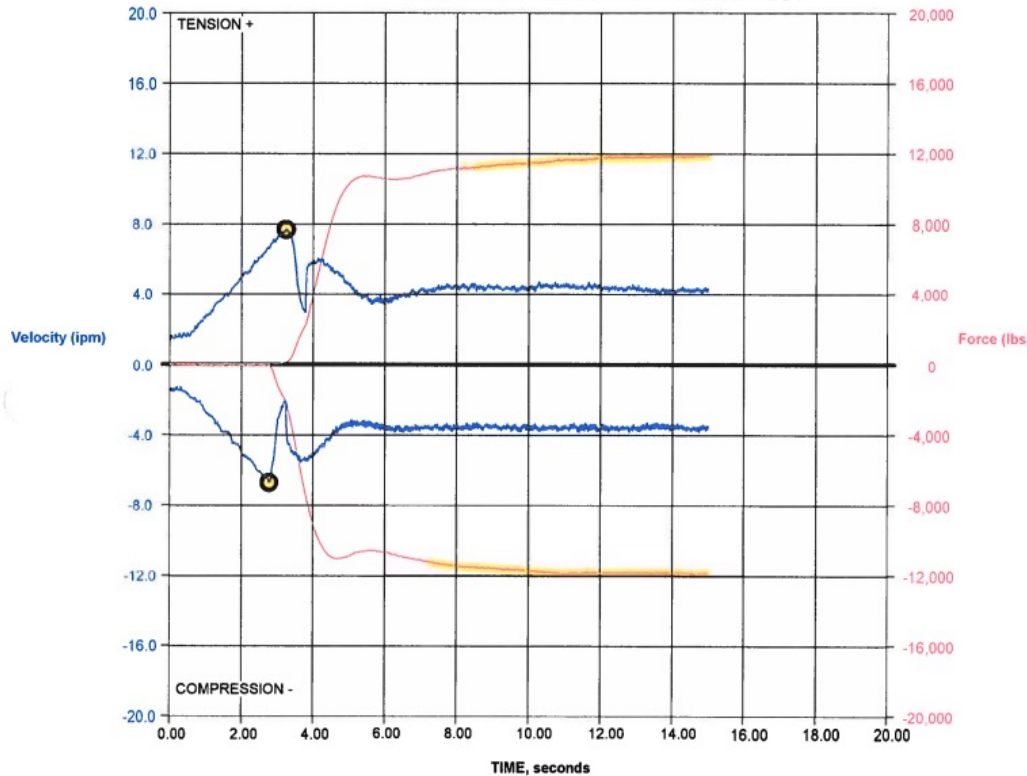
VA 80
FA 80
PA 0

Good Lockup & Bleed Test – Basic Eng.

Test Date : 3/20/2023
Test Time : 3:57:49 AM
Amb Temp : 74 F

Hanger Number : 33-HS-02
Snubber Type : ITT 2.5 X 5
Work Order : C93737123

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	1.20/10.90	7.69	-6.71
Bleed Rate (ipm)	0.10/25.00	4.34	-3.56
Test Load (lb)	11,250/12,500	11641	-11732

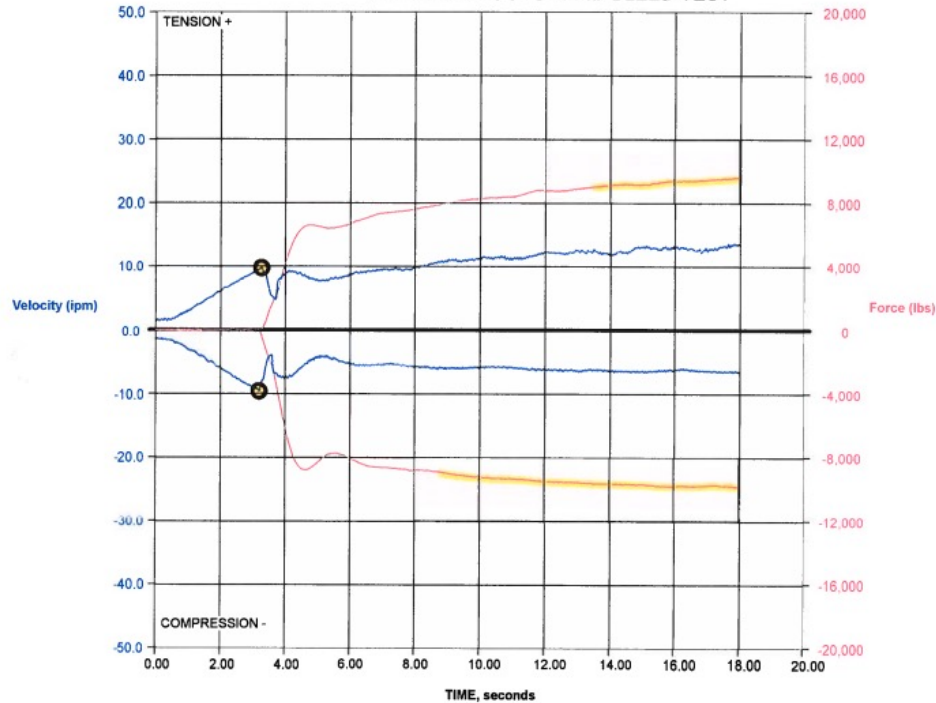
VA 8
FA 8
PA 2

Good Lockup & Bleed Test – ITT Grinnell Fig-200

Test Date : 3/22/2023
Test Time : 1:28:30 AM
Amb Temp: 74 F

Hanger Number : 39-HS-20
Snubber Type : BP 2.5 X 6
Work Order : C93801680

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	1.20/17.10	9.77	-9.61
Bleed Rate (ipm)	2.00/25.00	12.76	-6.19
Test Load (lb)	9,000/11,000	9271	-9582

VA 80
FA 80
PA 0
PG 2.0
IG 1.00
RR 4.0

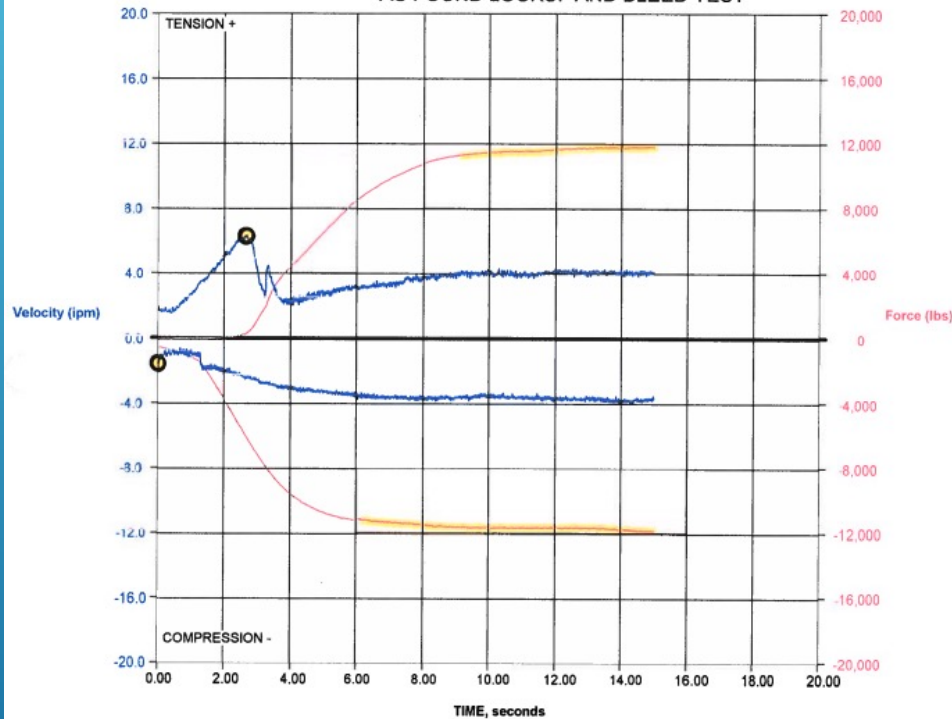
TEMP 74F

Unusual Plot – Bergen-Paterson

Test Date : 3/25/2023
 Test Time : 1:58:14 AM
 Amb Temp: 70 F

Hanger Number : 40-HS-01
 Snubber Type : ITT 2.5 X 5
 Work Order : C93902858

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	1.00/12.60	6.31	-1.56
Bleed Rate (ipm)	2.00/20.00	4.04	-3.64
Test Load (lb)	11,250/12,500	11583	-11618

TEMP 70 F

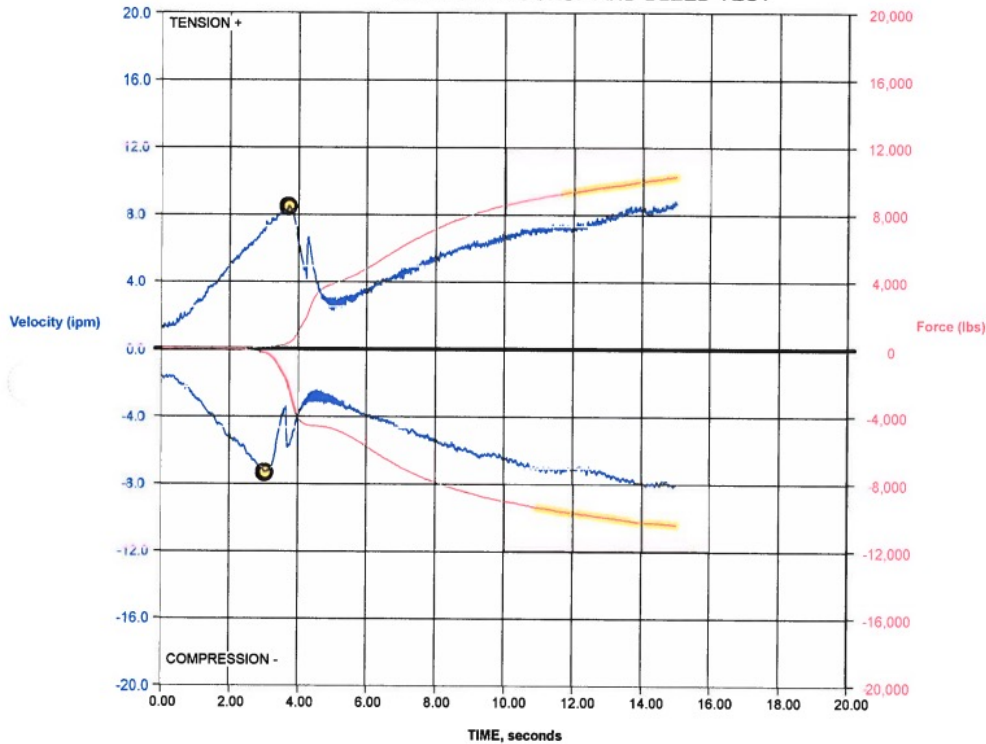
VA 80
 FA 80
 PA 0
 PG 0.5
 IG 0.5
 RR 3.0
 TT 15

Unusual Plot – ITT Grinnell Fig-200

Test Date : 3/24/2023
 Test Time : 3:02:30 AM
 Amb Temp: 70 F

Hanger Number : 40-HS-04
 Snubber Type : ITT 2.5 X 5
 Work Order : C93801682

AS FOUND LOCKUP AND BLEED TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Lockup Rate (ipm)	1.00/9.00	8.50	-7.33
Bleed Rate (ipm)	0.10/25.00	7.91	-7.50
Test Load (lb)	11,250/12,500	9779*	-9965*

* indicates need for evaluation

VA 80
 FA 80
 PA 0
 PG 0.5

Unusual Plot – ITT Grinnell Fig-200

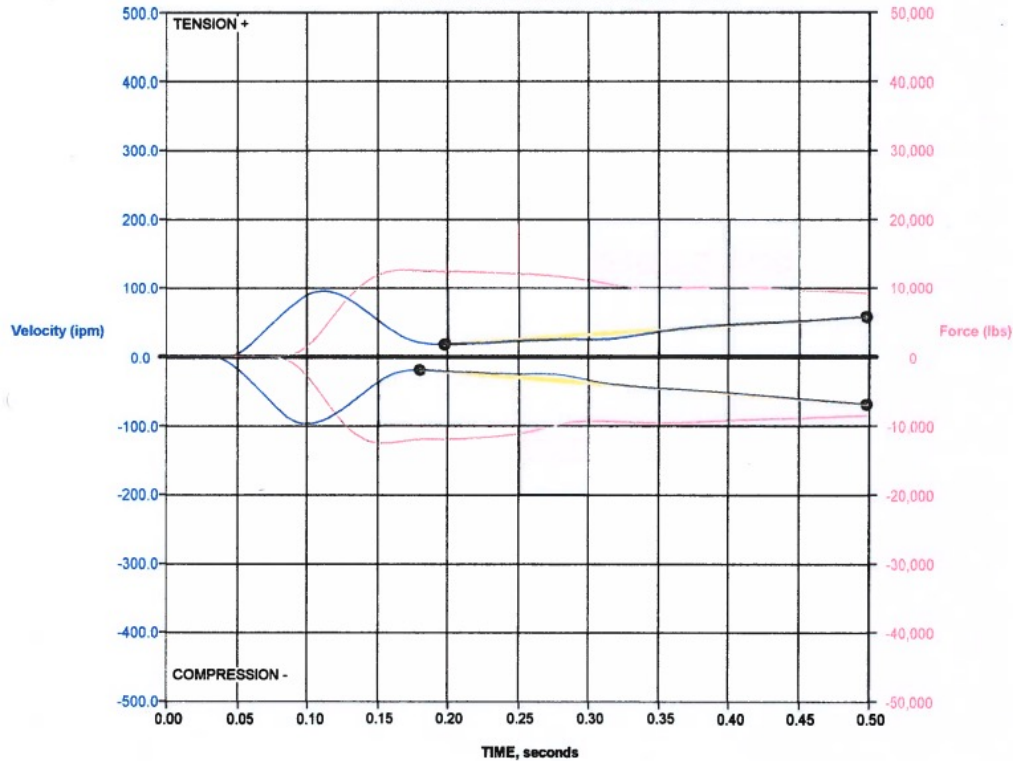
MECHANICAL SNUBBERS



Test Date : 4/20/2023
Test Time : 1:28:40 PM
Amb Temp: 70 F

Hanger Number : MSU-75
Snubber Type : PSA 10 GINNA
Work Order : C93909280

AS FOUND ACCELERATION TEST



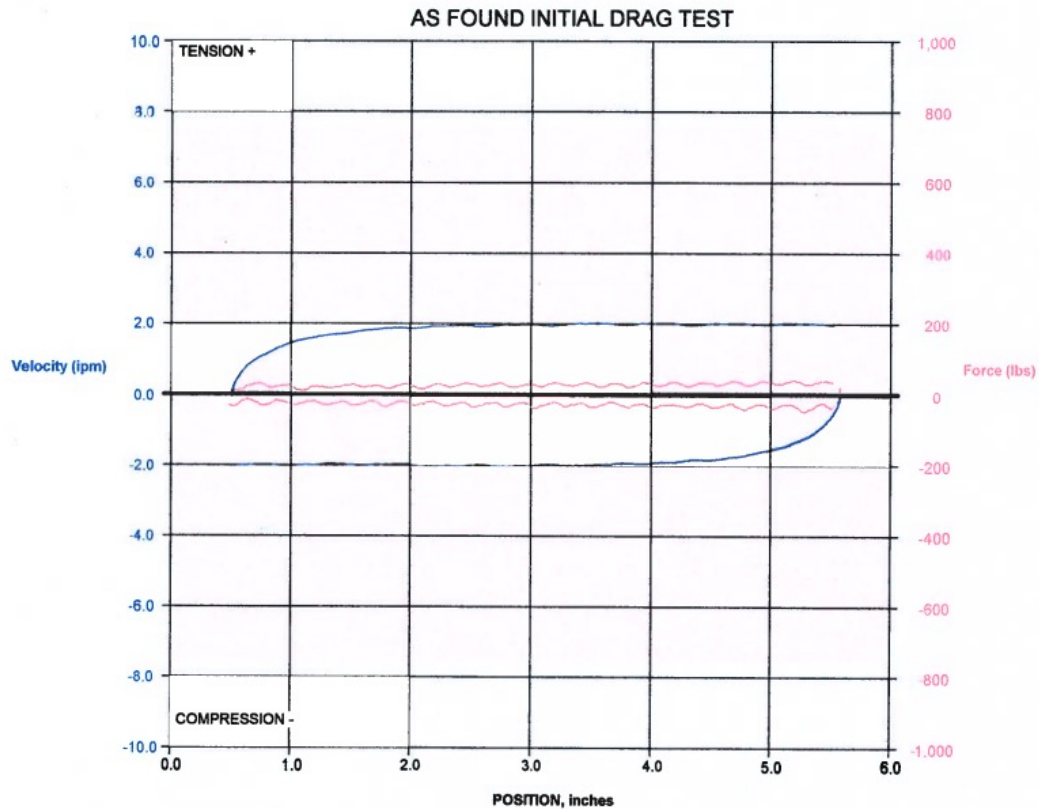
PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	0.006	-0.007
Test Load (lb)	12,000/15,000	12626	-12496

VA 90
FA 80
PA 0

Good Acceleration Test - PSA

Test Date : 4/20/2023
Test Time : 1:21:31 PM
Amb Temp: 70 F

Hanger Number : MSU-75
Snubber Type : PSA 10 GINNA
Work Order : C93909280



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Breakaway Load (lb)	0/750.0	13.7	-37.1
Peak Load (lb)	0/750.0	39.6	-48.5
Average Load (lb)	0/750.0	25.2	-26.1

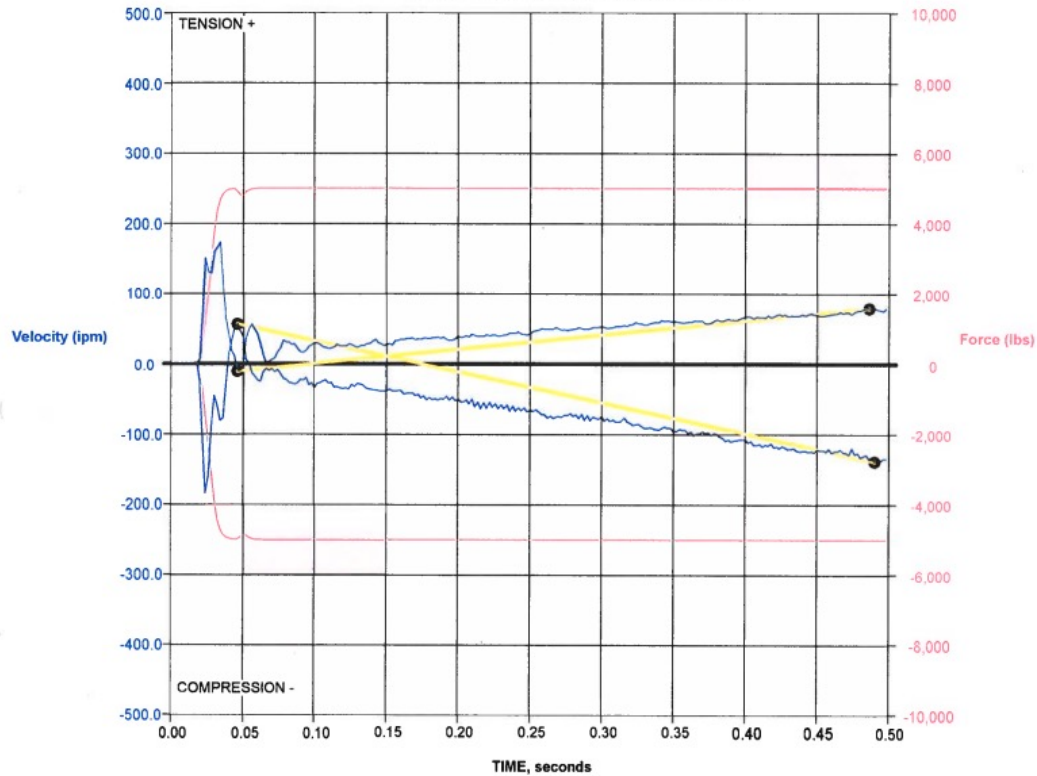
VA 90
EA 80

Good Drag Test - PSA

Test Date : 4/22/2023
Test Time : 2:50:27 PM
Amb Temp: 70 F

Hanger Number : MSU-60
Snubber Type : PSA 3 GINNA
Work Order : C93909502

AS FOUND ACCELERATION TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	0.009	-0.019
Test Load (lb)	4,800/6,000	5000	-5000

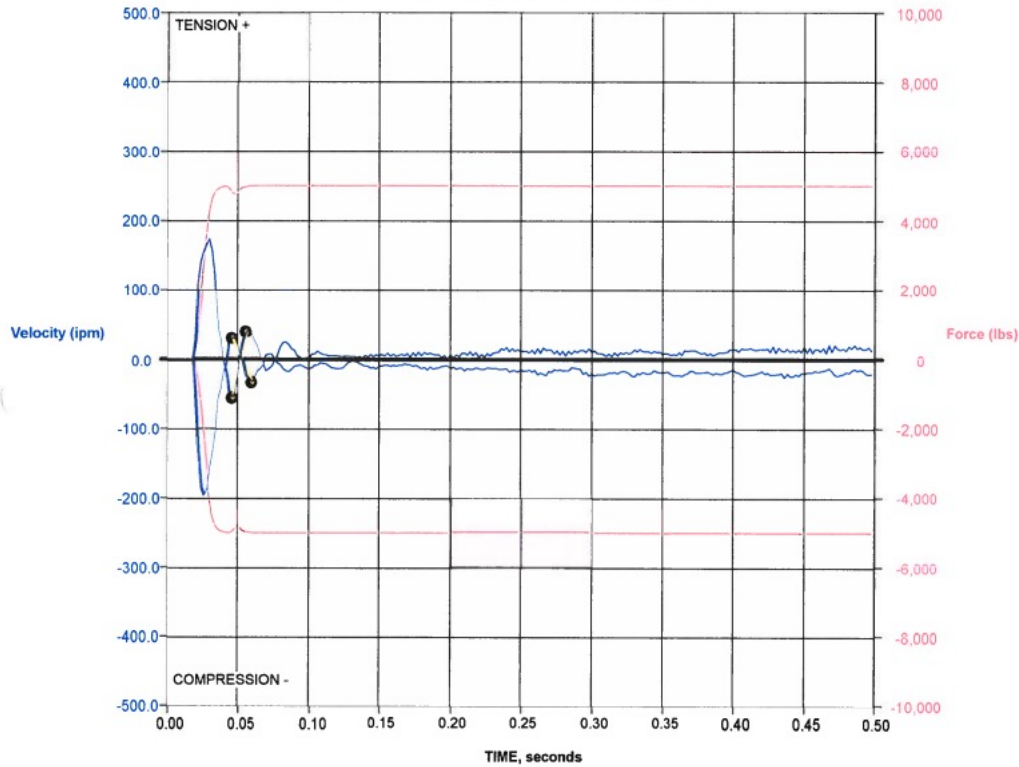
VA 50
FA 50

Unusual Plot - PSA

Test Date : 4/22/2023
Test Time : 1:54:17 PM
Amb Temp: 70 F

Hanger Number : MSU-55
Snubber Type : PSA 3 GINNA
Work Order : C93909502

AS FOUND ACCELERATION TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	<u>0.410*</u>	<u>-0.198*</u>
Test Load (lb)	4,800/6,000	5005	-4995

* indicates need for evaluation

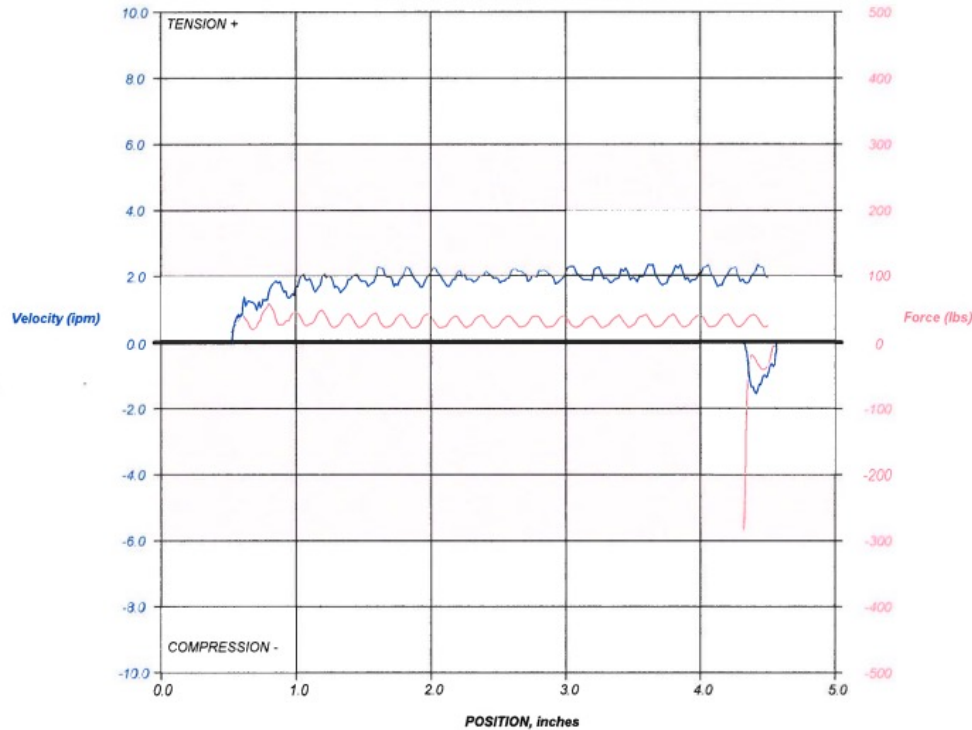
VA 50
FA 50
PA 50
PG 0.0

Unusual Plot - PSA

Test Date : 4/22/2023
Test Time : 1:02:39 PM
Amb Temp: 70 F

Hanger Number : MSU-57
Snubber Type : PSA 3 GINNA
Work Order : C93909502

AS FOUND INITIAL DRAG TEST



PARAMETER	MIN/MAX	TENSION	COMPRESSION
Breakaway Load (lb)	0/300.0	40.7	-41.4
Peak Load (lb)	0/300.0	56.6	-283.3
Average Load (lb)	0/300.0	30.9	-151.8

* Failed
Snubber locked up

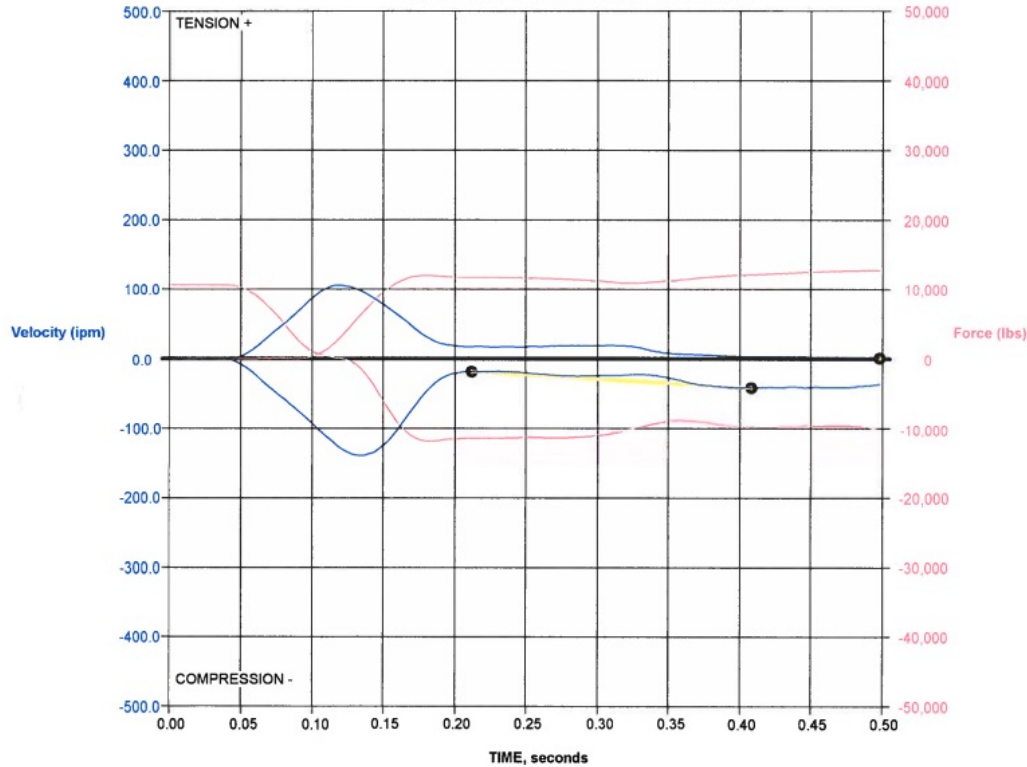
VA 50
FA 50
PA 50
PG 0.0
IG 0.00
RR 0.0

Unusual Plot - PSA

Test Date : 4/19/2023
Test Time : 10:47:31 PM
Amb Temp: 70 F

Hanger Number : MSU-74
Snubber Type : PSA 10 GINNA
Work Order : C93909262

AS FOUND ACCELERATION TEST



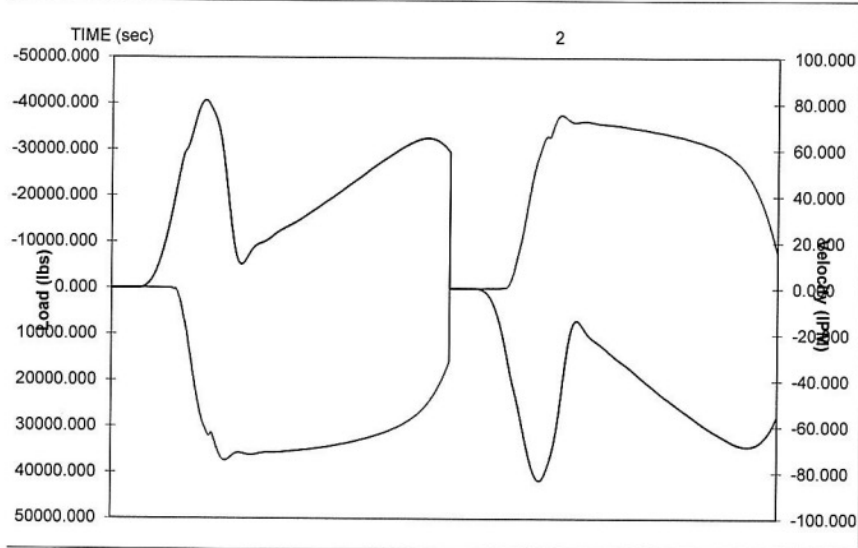
PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.020	0.000	-0.005
Test Load (lb)	12,000/15,000	12699	-11859*

* indicates need for evaluation

VA 90
FA 80
PA 0
PS 0

Unusual Plot - PSA

Functional Test



Functional Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid *BR 3-3-23*
Friday, March 03, 2023 08:57:38

Work Request Number: 122039342

Examination Number: 200195
Mark Number: 2-SNUB-003-5023
Component Number: M-1122-1
Snubber Ser. Number: 42417
Snubber Type: PSA-35

Cold Set: 0
Service Temp: 0
Ambient Temp: 71

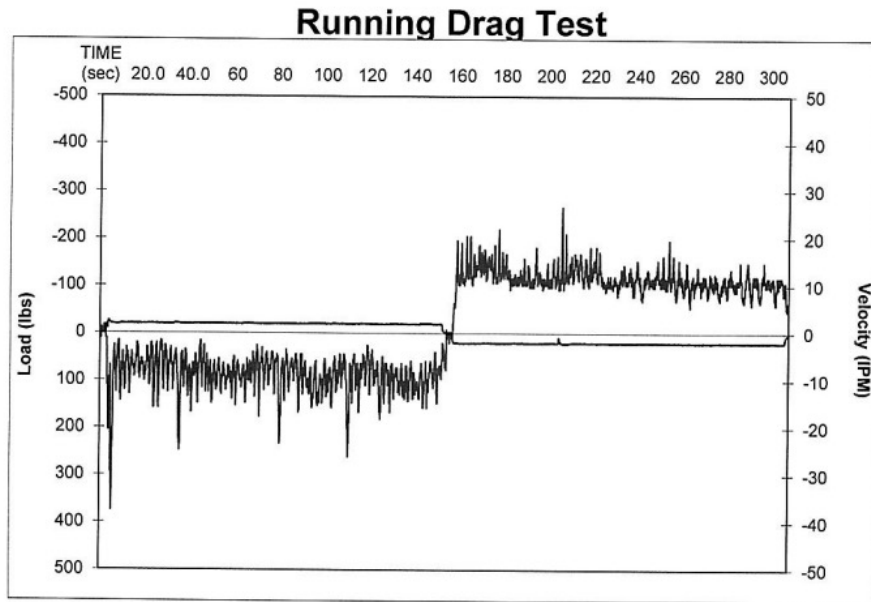
Rated Load: 50000
Operator Comment: FUNCTIONAL AS FOUND

Limiting Acceleration (Tension) = 0.0021 g's
Maximum Load Achieved (Tension) = 37,428.87 lbs. (74.86% of rated load)
Limiting Acceleration (Compression) = 0.0021 g's
Maximum Load Achieved (Compression) = 37,575.04 lbs. (75.15% of rated load)

Acceptable Tension Limiting Acceleration. (0< 0.04)
Acceptable Tension Load. (30000< 45000)
Acceptable Compression Limiting Acceleration. (0< 0.04)
Acceptable Compression Load. (30000< 45000)

Good Acceleration Test - PSA

Good Drag Test - PSA



Running Drag Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid
Friday, March 03, 2023 09:05:55

BR 3-3-23

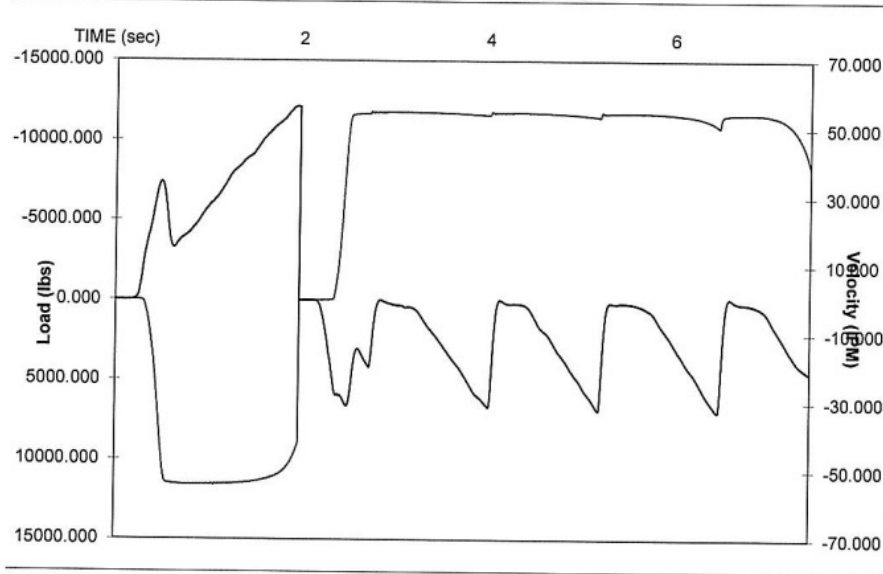
Examination Number: 200195
Mark Number: 2-SNUB-003-5023
Component Number: M-1122-1
Snubber Ser. Number: 42417
Snubber Type: PSA-35
Rated Load: 50000

Work Request Number: 122039342
Cold Set: 0
Service Temp: 0
Ambient Temp: 71

Operator Comment: RUNNING DRAG (FINAL) AS FOUND

Average Drag Force Experienced During Run (Tension) = 84.16 lbs. (0.17%)
Peak Drag Force Experienced During Run (Tension) = 372.50 lbs. (0.74%)
Average Drag Force Experienced During Run (Compression) = 114.52 lbs. (0.23%)
Peak Drag Force Experienced During Run (Compression) = 268.76 lbs. (0.54%)
Acceptable Tension Average Drag Force. (lbs. < 2500)
Acceptable Tension Peak Drag Force. (lbs. < 2500)
Acceptable Compression Average Drag Force. (lbs. < 2500)
Acceptable Compression Peak Drag Force. (lbs. < 2500)

Functional Test



Functional Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid
Wednesday, October 05, 2022 14:42:28

BA 10-5-22

Examination Number: 100145
Mark Number: 1-SNUB-010-5052
Component Number: M-1204-1
Snubber Ser. Number: 42605
Snubber Type: PSA-10
Rated Load: 15000
Operator Comment: FUNCTIONAL AS FOUND

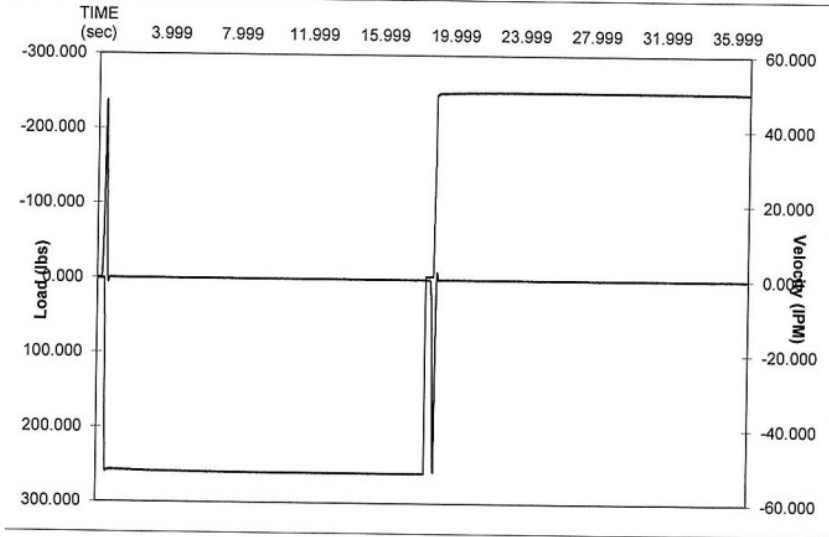
Work Request Number: 121745876
Cold Set: 0
Service Temp: 0
Ambient Temp: 71

Limiting Acceleration (Tension) = 0.0012 g's
Maximum Load Achieved (Tension) = 11,608.85 lbs. (77.39% of rated load)
Limiting Acceleration (Compression) = 0.0017 g's
Maximum Load Achieved (Compression) = 11,839.10 lbs. (78.93% of rated load)

Acceptable Tension Limiting Acceleration. (0< 0.04)
Acceptable Tension Load. (9000< 13500)
Acceptable Compression Limiting Acceleration. (0< 0.04)
Acceptable Compression Load. (9000< 13500)

Outside
Acceleration
Acceptance
Range - PSA

Functional Test



Functional Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid *BR 3-6-23*
Monday, March 06, 2023 12:52:08

Examination Number: 200278
Mark Number: 2-SNUB-001-5065
Component Number: M-1102-1
Snubber Ser. Number: 6666
Snubber Type: PSA-1/4
Rated Load: 350

Work Request Number: 123513891
Cold Set: 0
Service Temp: 0
Ambient Temp: 72

Operator Comment: FUNCTIONAL AS FOUND

Limiting Acceleration (Tension) = 0.0000 g's
Maximum Load Achieved (Tension) = 260.85 lbs. (74.53% of rated load)
Limiting Acceleration (Compression) = 0.0000 g's
Maximum Load Achieved (Compression) = 248.10 lbs. (70.89% of rated load)

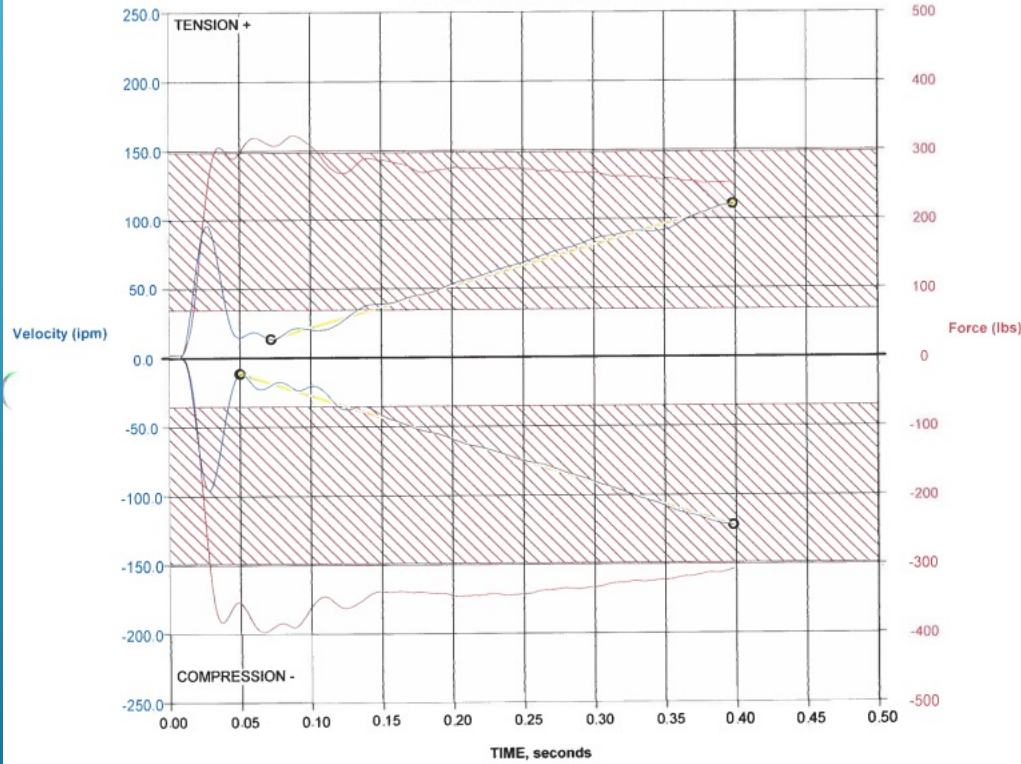
Acceptable Tension Limiting Acceleration. (0 < 0.04)
Acceptable Tension Load. (210 < 315)
Acceptable Compression Limiting Acceleration. (0 < 0.04)
Acceptable Compression Load. (210 < 315)

Outside
Acceleration
Acceptance
Range - PSA

Test Date : 2/2/2023
Test Time : 1:03:36 AM
Temperature : 72 F

Hanger Number : RH21-2984S
Snubber Type : PSA 1/4
Work Order : 05237382-02

AS FOUND ACCELERATION TEST

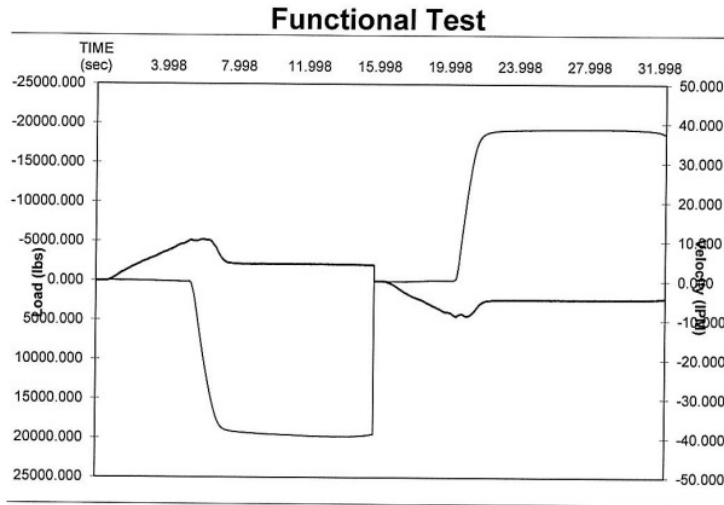


PARAMETER	MIN/MAX	TENSION	COMPRESSION
Acceleration (g)	0.000/0.040	0.013	-0.014
Test Load (lb)	70/298	323*	-397*

VA 8
FA 8
PA 0

Unusual Plot - PSA

Good Acceleration Test – Anchor Darling



Functional Test Results

Wyle Model 150 / S.N. 119 - Operator: Benny Reid *BR-25-23*
Saturday, February 25, 2023 08:57:28

Examination Number: 200184
Mark Number: 2-SNUB-074-5037
Component Number: H-4071
Snubber Ser. Number: ADH-2000-1591
Snubber Type: ADH-20
Rated Load: 20000
Operator Comment: FUNCTIONAL AS FOUND

Work Request Number: 122039315
Cold Set: 0
Service Temp: 0
Ambient Temp: 71

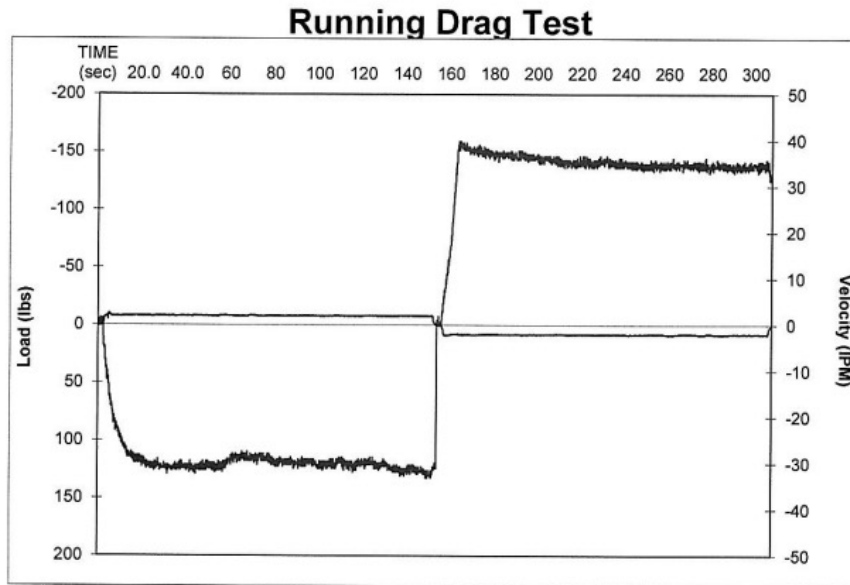
Bleed Rate (Tension) = 4.33 IPM
Lockup Velocity (Tension) = 10.55 IPM
Maximum Load Achieved (Tension) = 19,834.17 lbs. (99.17% of rated load)
Bleed Rate (Compression) = 4.65 IPM
Lockup Velocity (Compression) = 9.00 IPM
Maximum Load Achieved (Compression) = 19,406.33 lbs. (97.03% of rated load)

Acceptable Tension Bleed Rate. (2< IPM < 10)
Acceptable Tension Lockup Velocity. (1< IPM < 30)
Acceptable Tension Load. (18000<lbs<20000)
Acceptable Compression Bleed Rate. (2< IPM < 10)
Acceptable Compression Lockup Velocity. (1< IPM < 30)
Acceptable Compression Load. (18000< lbs < 20000)

Test Status (Tension/Compression): ACCEPTABLE/ACCEPTABLE

Good Drag Test

Anchor Darling



Running Drag Test Results

Wyle Model 150 /S.N. 119 - Operator: Benny Reid
Saturday, February 25, 2023 09:04:51

BR 2-25-23

Examination Number: 200184
Mark Number: 2-SNUB-074-5037
Component Number: H-4071
Snubber Ser. Number: ADH-2000-1591
Snubber Type: ADH-20
Rated Load: 20000
Operator Comment: RUNNING DRAG (FINAL) AS FOUND

Work Request Number: 122039315
Cold Set: 0
Service Temp: 0
Ambient Temp: 71

Average Drag Force Experienced During Run (Tension) = 118.66 lbs. (0.59%)
Peak Drag Force Experienced During Run (Tension) = 135.54 lbs. (0.68%)
Average Drag Force Experienced During Run (Compression) = 134.89 lbs. (0.67%)
Peak Drag Force Experienced During Run (Compression) = 158.40 lbs. (0.79%)
Acceptable Tension Average Drag Force. (lbs. < 800)
Acceptable Tension Peak Drag Force. (lbs. < 800)
Acceptable Compression Average Drag Force. (lbs. < 800)
Acceptable Compression Peak Drag Force. (lbs. < 800)

CONCLUSION to Unusual Test Plots



Business Meeting

SNUBBER USERS GROUP, INC. 2023 BUSINESS MEETING

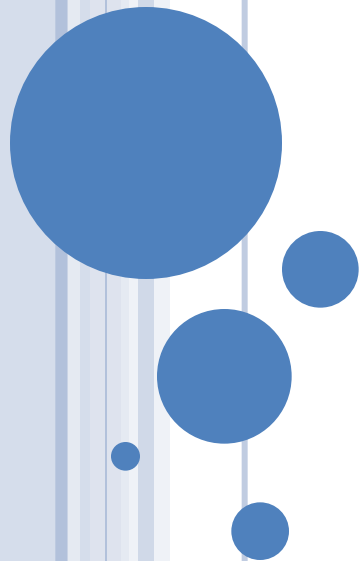
Mitch Etten-Bohm

President & Chairman of BOD

Business Meeting

ROLL CALL

SUMMER 2023



Current Active Member Plants

Up to four candidates may be voted for.

One ballot per Member Site.

Top four elected regardless of number of votes.



CURRENT ACTIVE MEMBER PLANTS



- Arkansas Nuclear One
- Braidwood
- Browns Ferry
- Brunswick
- Byron
- Callaway
- Calvert Cliffs
- Catawba
- Cernavoda
- Clinton
- Columbia
- Comanche Peak
- Cook
- Cooper
- Davis-Besse
- Diablo Canyon
- Dresden
- Farley
- Fermi
- FitzPatrick
- Ginna
- Grand Gulf
- Harris
- Hatch
- Hope Creek
- Krsko
- LaSalle
- Limerick
- McGuire
- Millstone
- Monticello
- Nine Mile
- North Anna
- Oconee
- Palo Verde
- Peach Bottom
- Perry
- Point Beach
- Prairie Island
- Quad Cities
- River Bend
- Robinson
- Salem
- Seabrook
- Sequoyah
- South Texas
- St. Lucie
- Summer
- Susquehanna
- Vogtle
- Watts Bar
- Wolf Creek



Current SNUG Board of Directors

Terms expiring 2023	Scott Esposito Bob Fandetti Stephanie McCormick Joe Pawasarat (resigned, slot open)
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Terms expiring 2024	Tim Canter John Catano Nate Frank Steve Norman
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Terms expiring 2025	Ed Dundon Mitch Etten-Bohm Mario Mazzuca Marissa Post (resigned, slot open)
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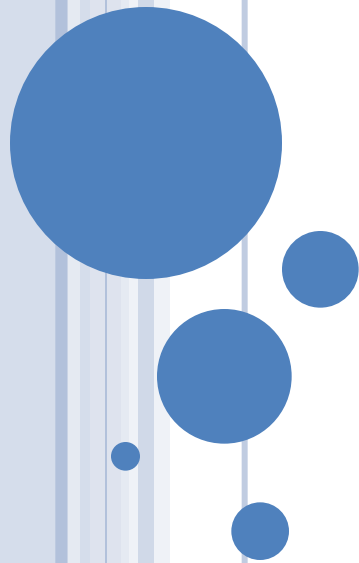
Business Meeting

INTRODUCTION OF NOMINEES

Mitch Etten-Bohm

President & Chairman of BOD

2023 - 2026 Terms



SNUG Board of Directors Nominees

- **Gus Avila**
- **Scott Esposito**
- **Bob Fandetti**
- **Stephanie McCormick**

Up to four candidates may be voted for.

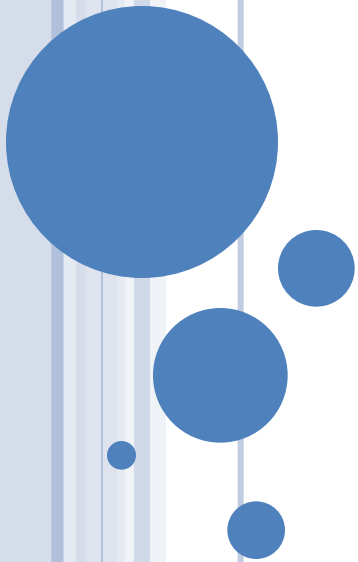
One ballot per Member Site.

Top four elected regardless of number of votes.



Business Meeting

ELECTION OF DIRECTORS





SNUBBER USERS GROUP

Current Financial Status

Presented by Steve Norman

SNUG Treasurer & Chief Financial Officer

Summer 2023 Conference & Trade Show

July 17, 2023

Status as of January 1, 2023

- Account Balances

- Checking Account \$ 10,318.84
- Money Market Account \$ 25,696.27

Total \$ 36,015.11

Downloaded from <http://ajph.org/> on November 10, 2014

Current Status

Beginning Balance	\$ 36,015.11
Expenditures	\$ 3,757.33
Income	\$ 30,015.96
Current Total	\$ 62,273.74

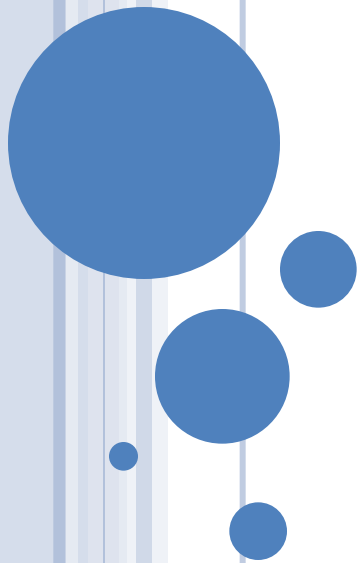
SNUBBER USERS GROUP

Current Financial Status



Business Meeting

ELECTION RESULTS



Business Meeting

ELECTION RESULTS

Your New Directors for 2023 – 2026 are:

- **Gus Avila**
- **Scott Esposito**
- **Bob Fandetti**
- **Stephanie McCormick**

Business Meeting

**ADJOURN
SNUBBER USERS GROUP, INC.
2023 BUSINESS MEETING**

Mitch Etten-Bohm

President & Chairman of BOD

DAILY ADJOURNMENT

BUSSES LEAVE FOR TOP GOLF @ 5:15 PM

DON'T BE LATE

TUESDAY'S SESSION BEGINS
8:00 AM



DAILY ADJOURNMENT

TUESDAY'S SESSION BEGINS
8:00 AM

ALL ATTENDEES SHOULD REPORT TO
THE MAIN MEETING ROOM TO BEGIN
THE SESSIONS FOR THE DAY ON
TUESDAY.

