

Corrosion within the Z-Bed Recovery Systems at the Savannah River Site's Tritium Facilities

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Savannah River Nuclear Solutions, LLC
April 23th-25th, 2013

UNCLASSIFIED

Does Not Contain Controlled Nuclear Information

Reviewing Official: Jared Clark, Sr. Engineer, TED SRNS
Date: 4/16/2013

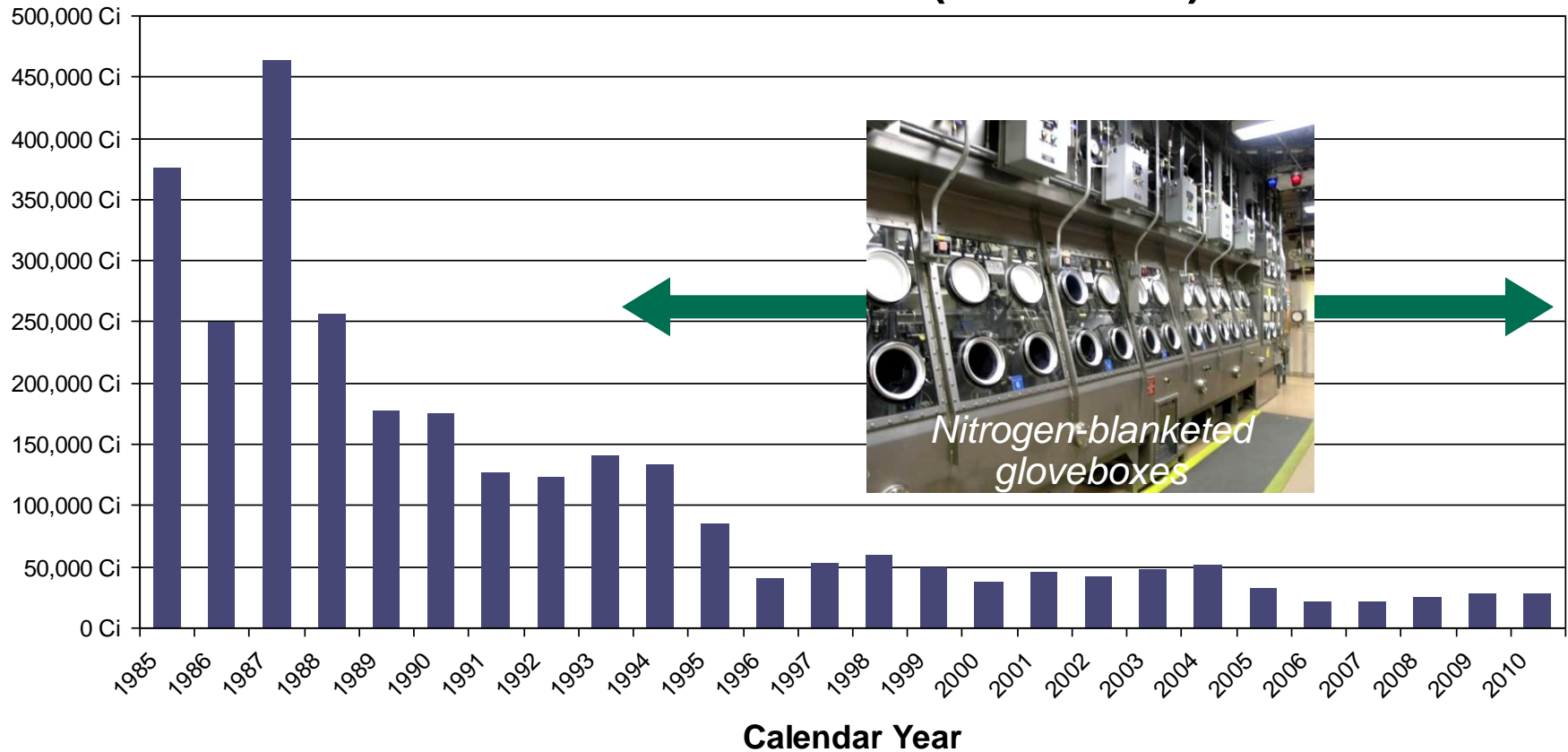
Tritium Focus Group

AGENDA

- Stewardship
- Glovebox Stripper System Overview
- Z-Bed Recovery System Overview
- Corrosion
 - Signs
 - Mechanisms
 - Facilitators
 - Mitigation Strategies
 - System Performance Impacts
- Summary

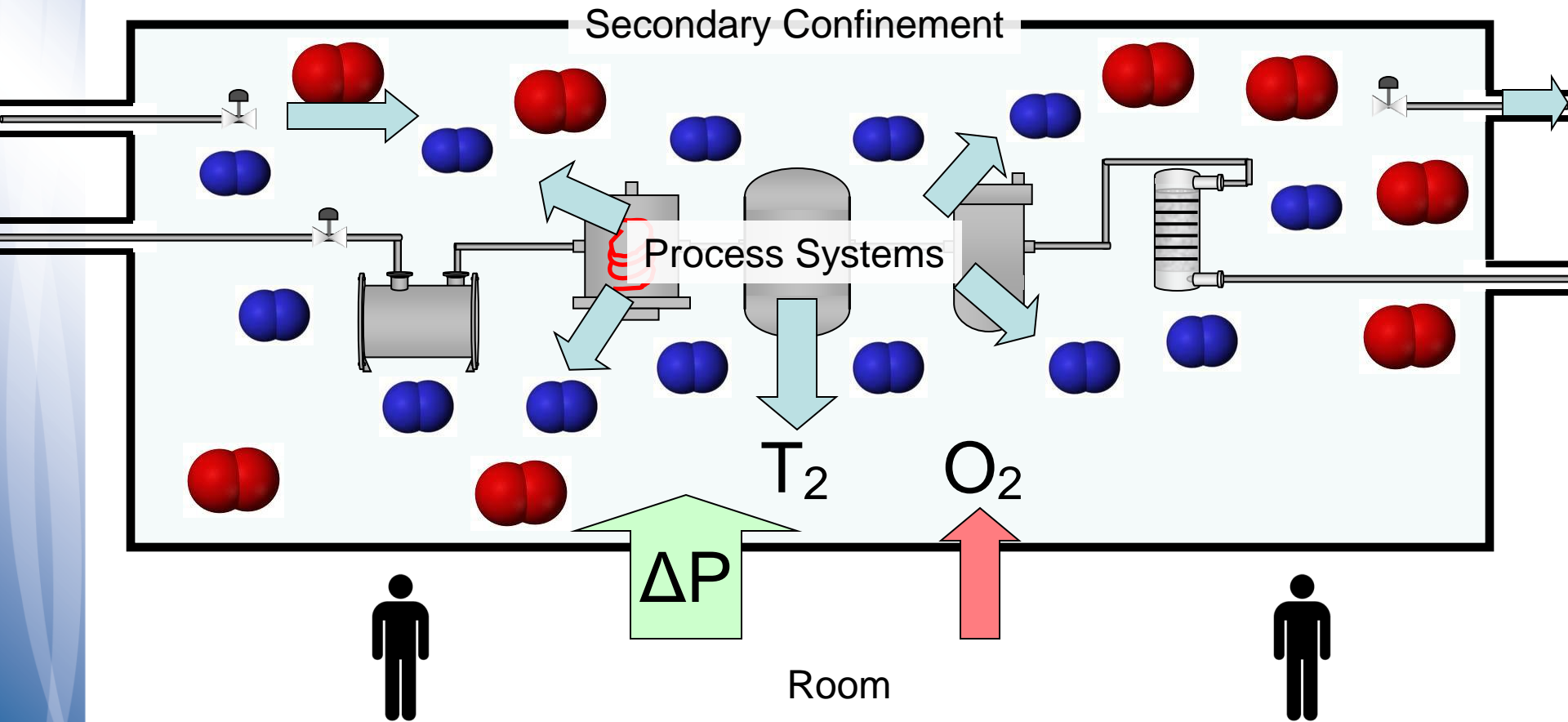
STEWARDSHIP - SAFE TRITIUM OPERATIONS

Annual Tritium Releases (1985-2010)

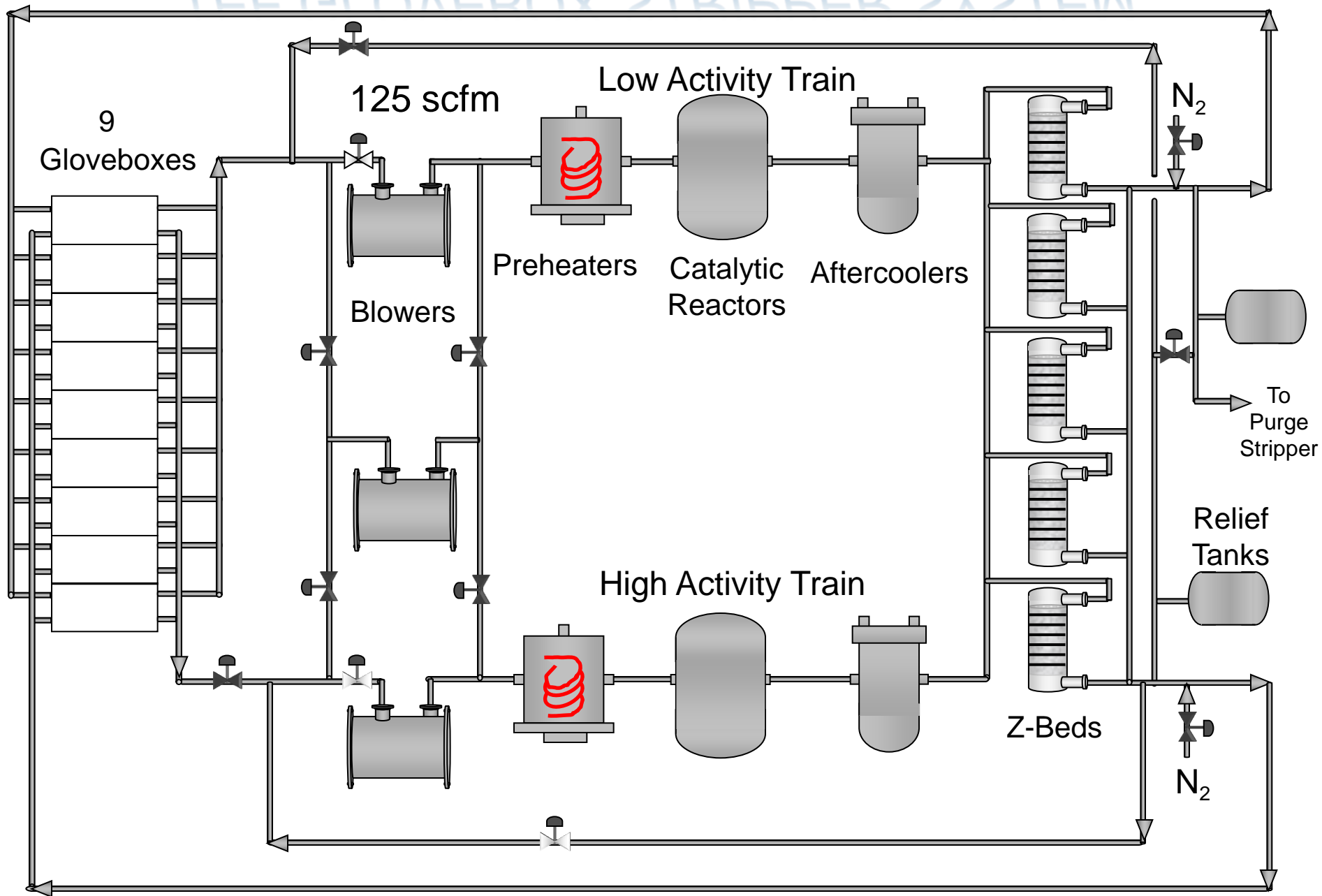


Glovebox Stripper System Overview

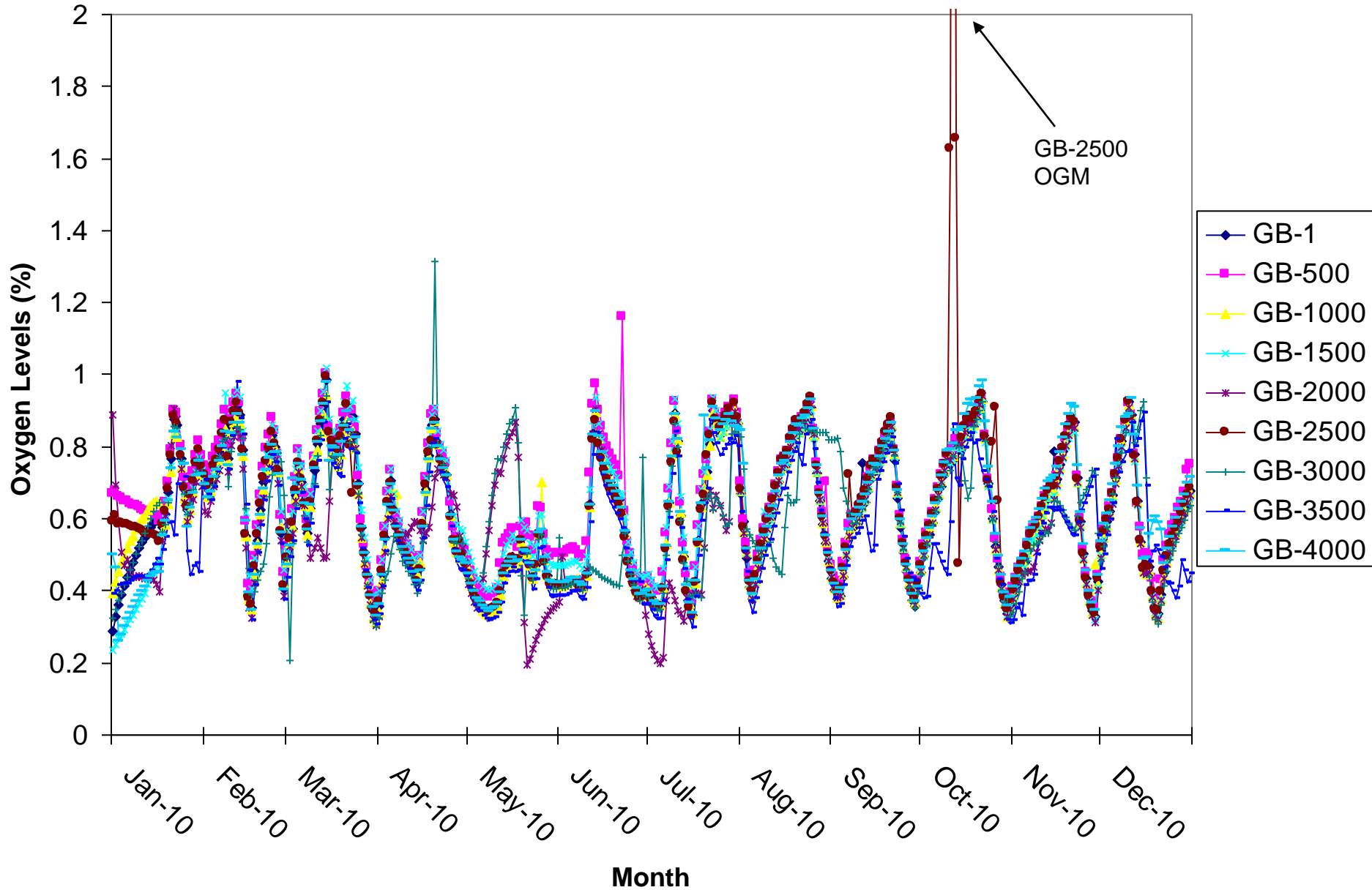
GENERAL CONCEPT



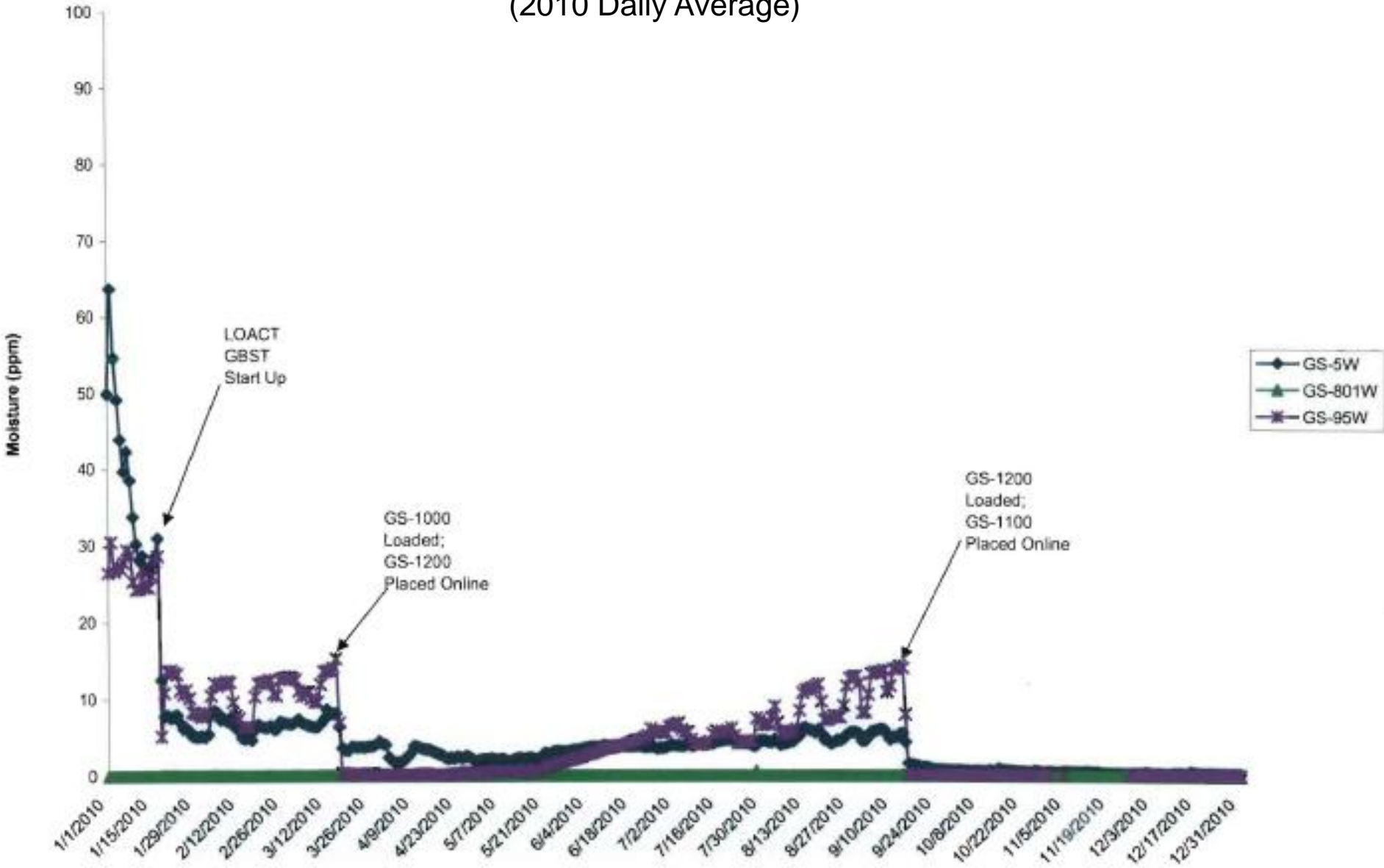
TEF GLOVEBOX STRIPPER SYSTEM



Glovebox Oxygen Levels (2010 Daily Average)

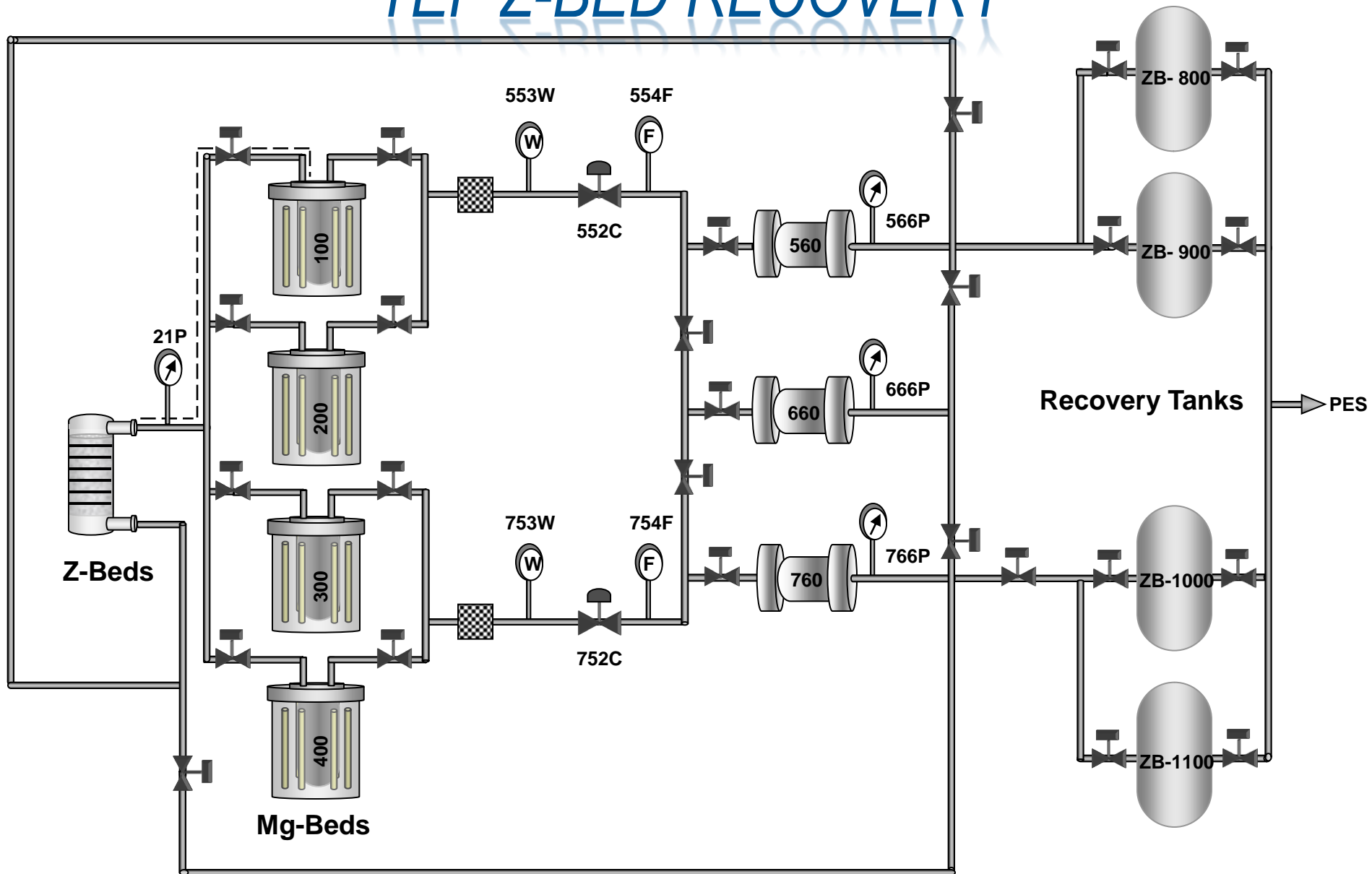


Glovebox Stripper Low Activity Train Moisture (2010 Daily Average)

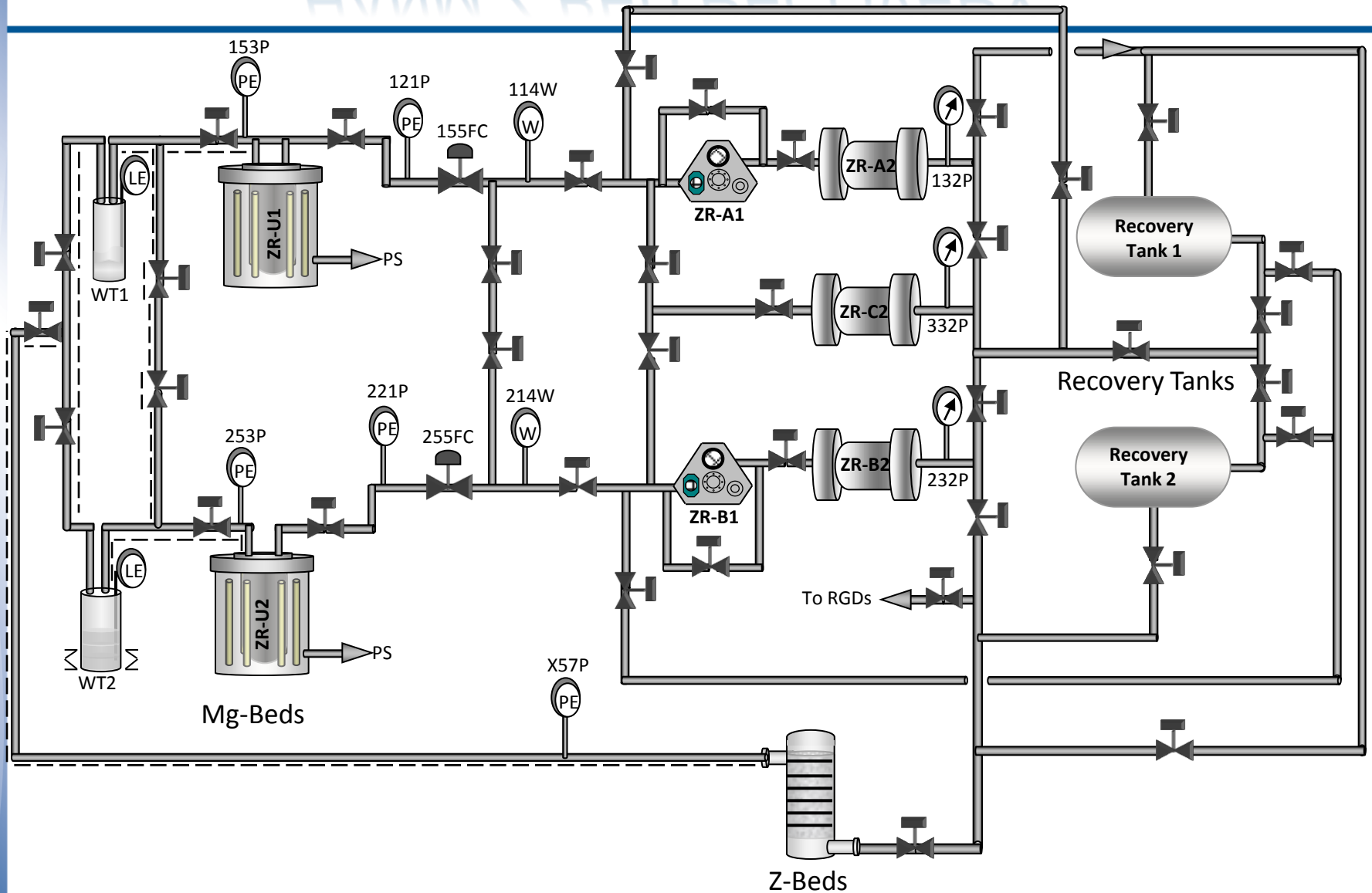


Z-Bed Recovery System Overview

TEF Z-BED RECOVERY



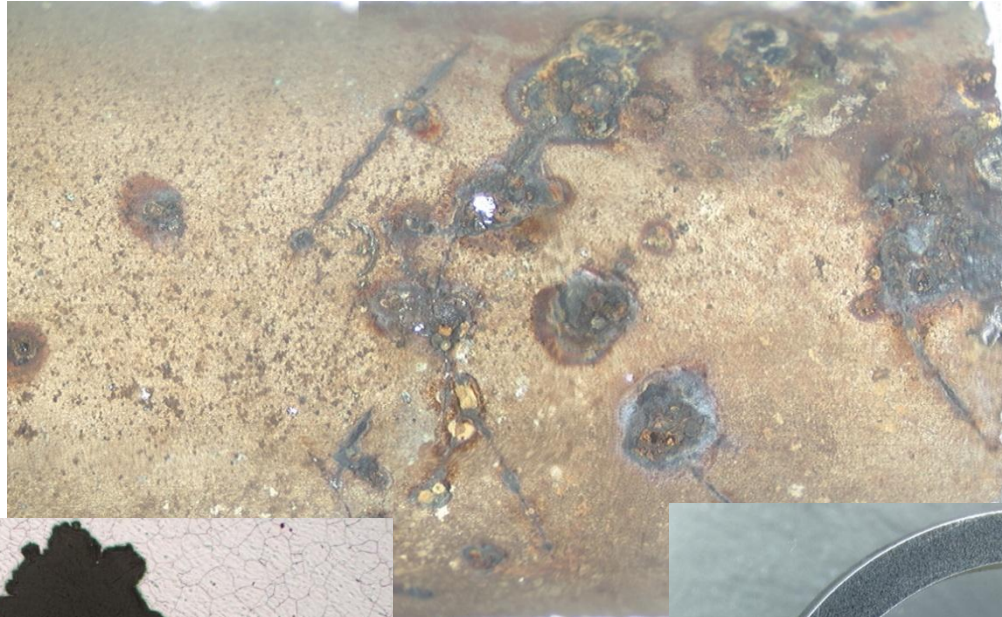
HANM Z-BED RECOVERY



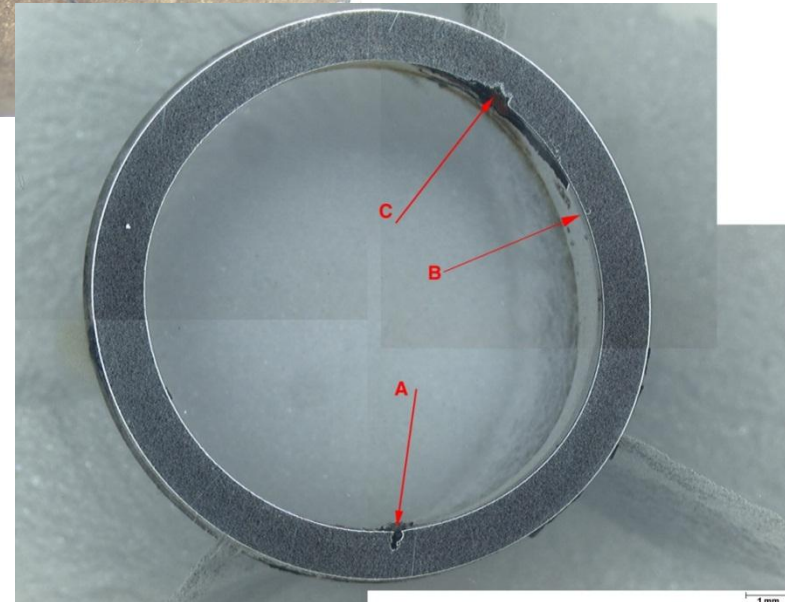
SIGNS OF CORROSION



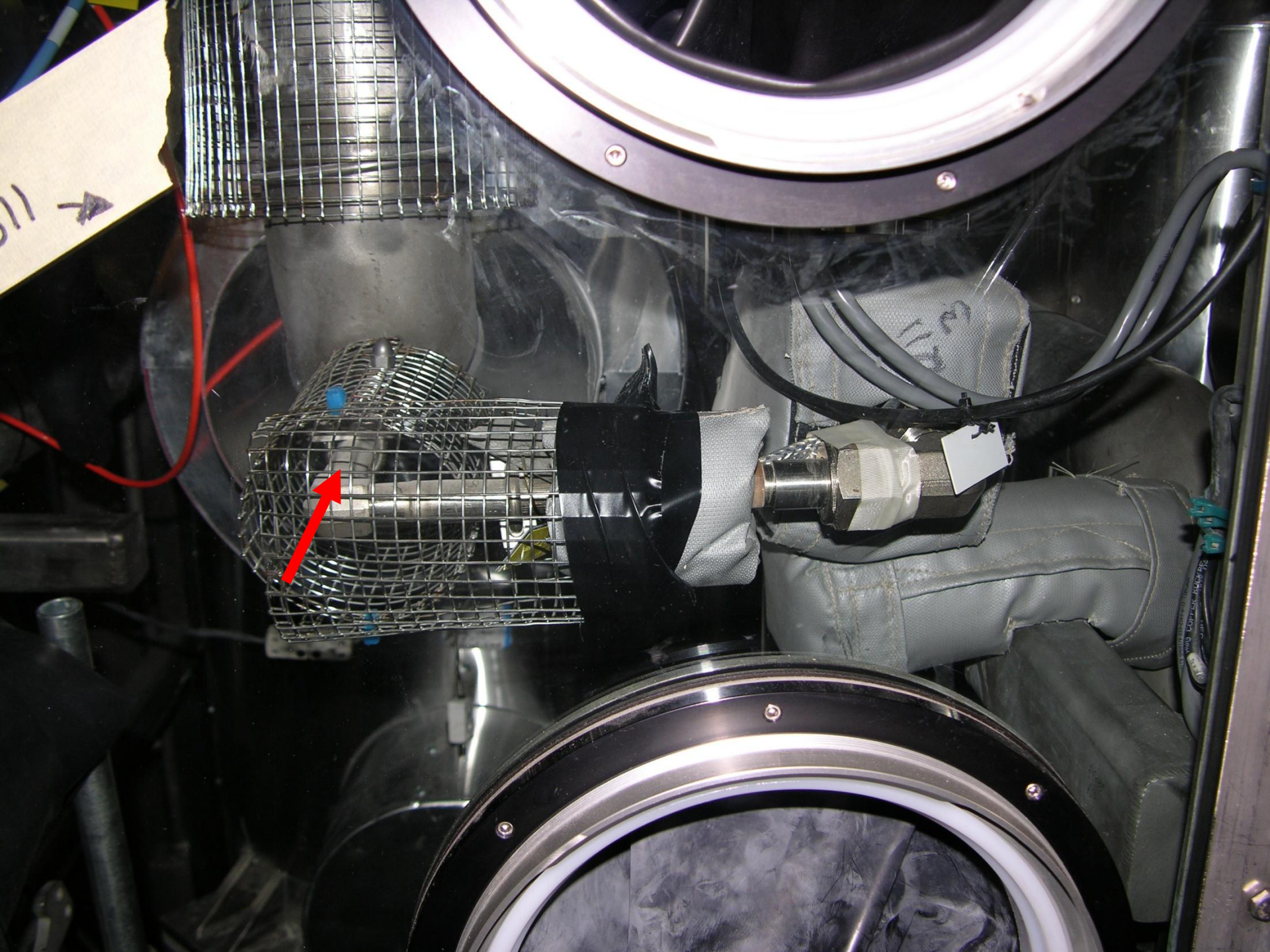
P2 STRIPPER HEADER, 2005



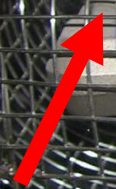
200 μm



1 mm



111 →



www.coprec.com



GS-1000



GS-1100



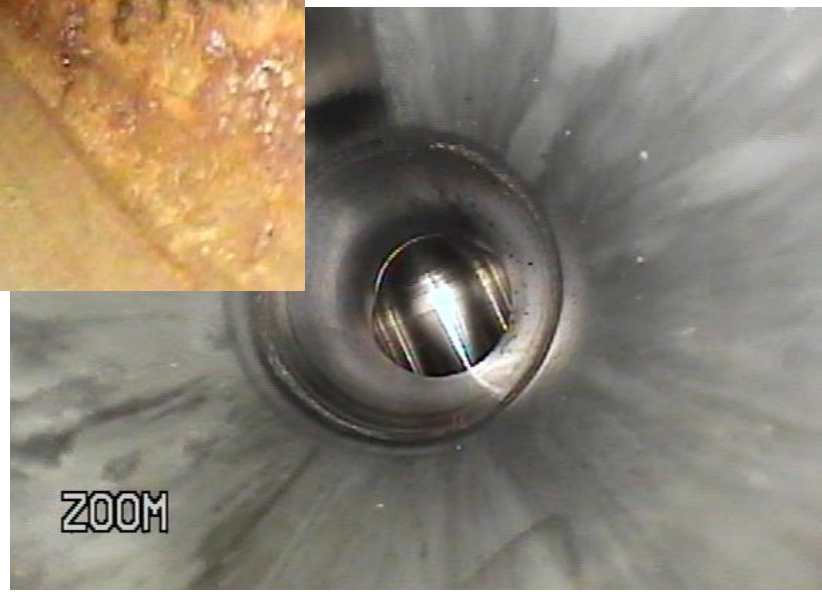
ZOOM

GS-1300



ZOOM

GS-1200

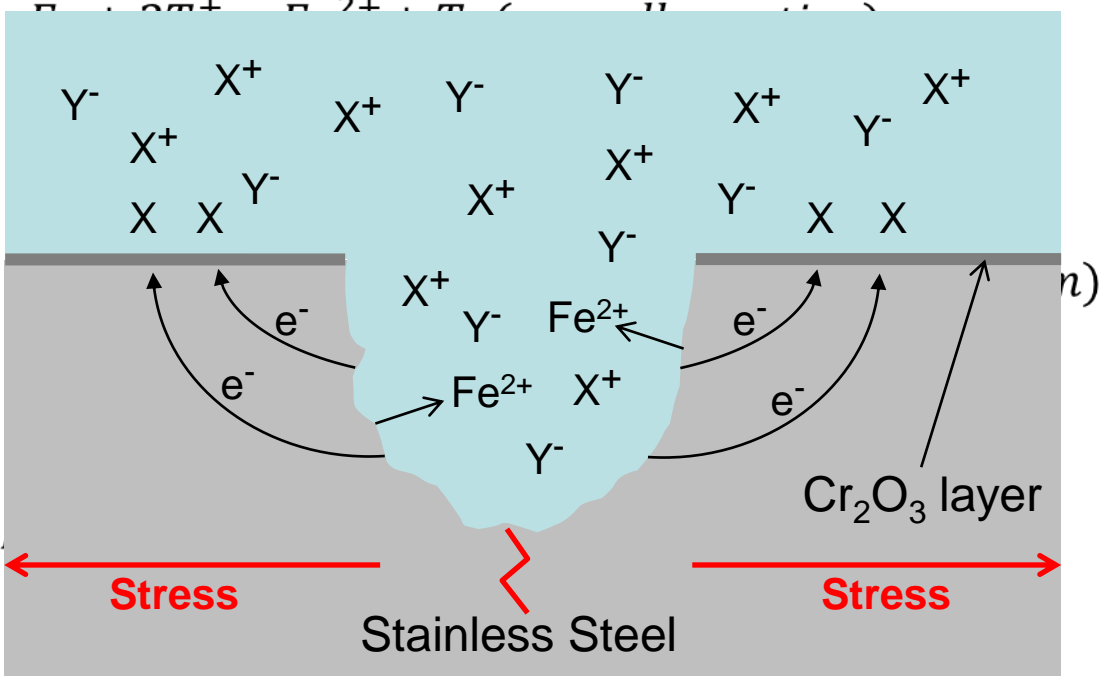
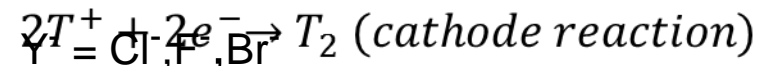
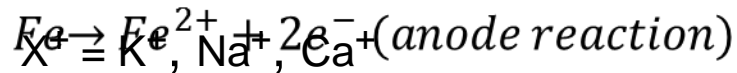


ZOOM

GS-1400

HALIDE ATTACK & STRESS CORROSION

- Mechanisms



CORROSION FACILITATORS

- Halides
- Oxygen depleted environment
- Tensile Stress
- Temperature
- Pressure

STRESS CORROSION CRACKING

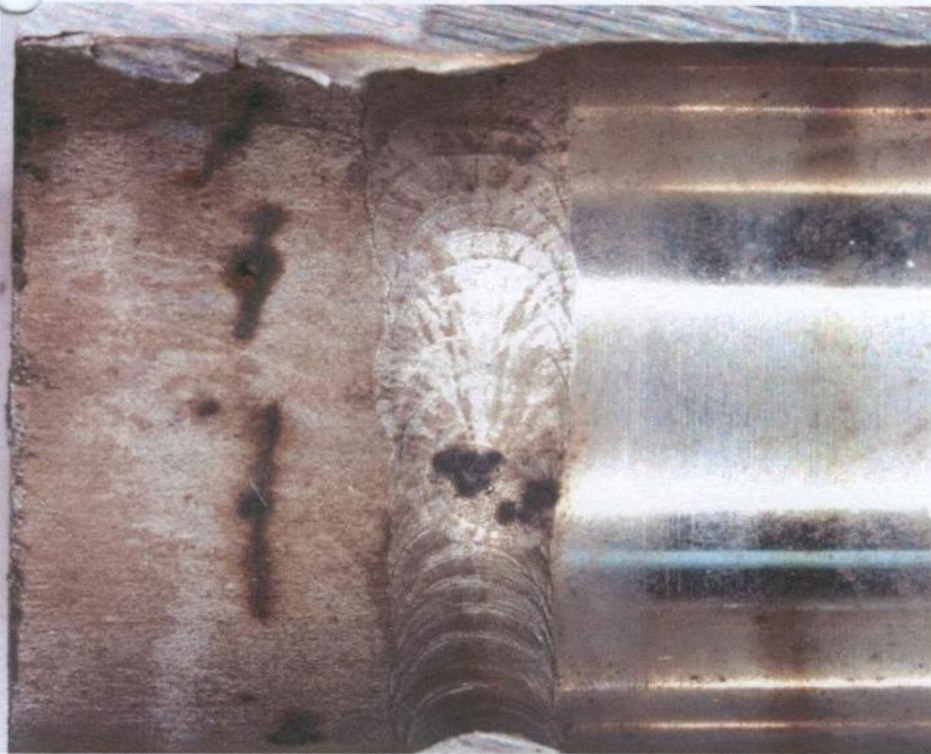


Figure 37
Piece I

Photo #: 0501A00450
Magnification: 6X



Figure 38
Piece I

Photo #: 0501A00452
Magnification: 15X

STRESS CORROSION CRACKING (CONT.)

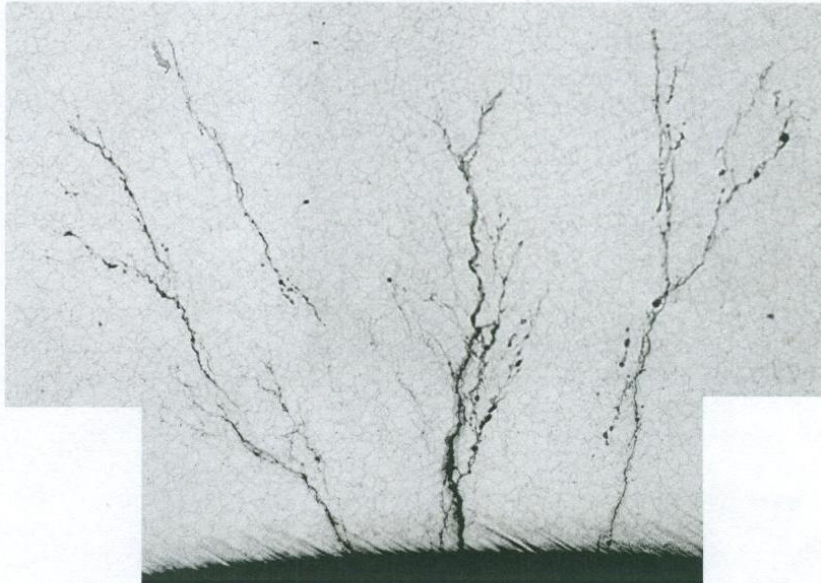


Figure 43
Etch: 60% Nitric Acid

Photo #: 0502A00326
Magnification: 50X



Figure 42
Etch: 60% Nitric Acid

Photo #: 0502A00349
Magnification: 160X

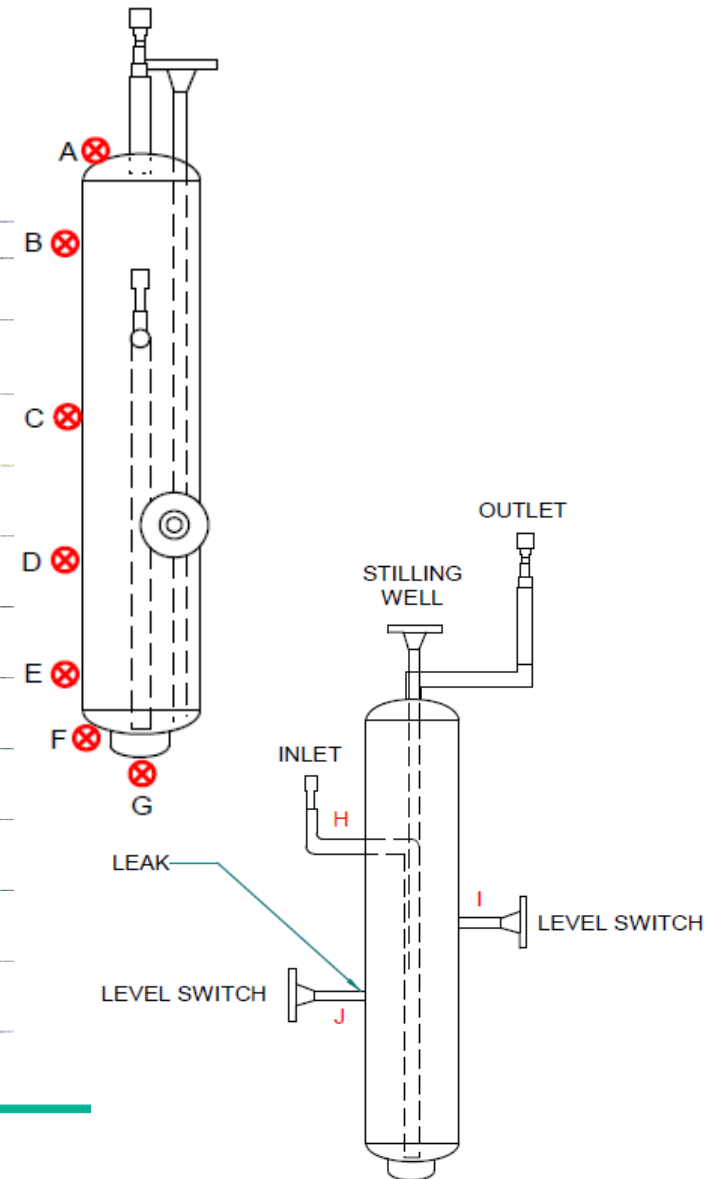
MITIGATION STRATEGIES

- Awareness
- Inspection intervals and periodic non-destructive (NDE) monitoring for areas of concern

FIELD INSPECTION OF WATER TRAPS

- **Water Trap #1, Ultrasonic Testing (UT)**
 - December 12, 2011

Location	0°	90°	180°	270°
A	N/A	N/A	N/A	N/A
B	0.332"	N/A	N/A	N/A
C	0.304"	0.322"	0.314"	0.302"
D	0.302"	0.331"	0.307"	0.302"
E	0.302"	0.326"	0.307"	0.309"
F	N/A	N/A	N/A	N/A
G	N/A	N/A	N/A	N/A
N/A	N/A	N/A	N/A	N/A
H	N/A	0.121"	N/A	N/A
I	0.121"	0.126"	0.129"	0.124"
J	0.126"	0.129"	0.122"	0.120"



FIELD INSPECTION OF WATER TRAPS

- **Field Inspections using Olympus Borescope**

- July 19, 2005

- Water Trap #2

- No signs of pitting, no staining
- Stilling Well

- July 11, 2012

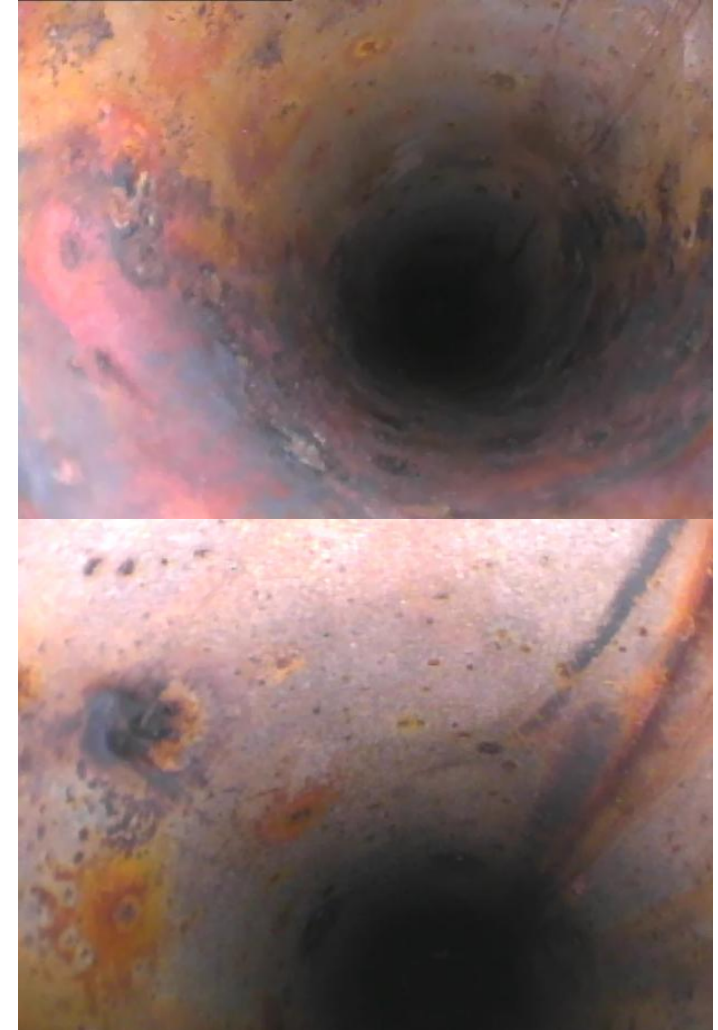
- Water Trap #1

- Evidence of Corrosion and Pitting
- Stilling Well
- Level Switch Wells

- September 11, 2012

- Water Trap #2

- Evidence of Corrosion and Pitting
- Stilling Well
- Level Switch Wells



MITIGATION STRATEGIES

- Awareness
- Inspection intervals and periodic non-destructive (NDE) monitoring for areas of concern
- Material Selection

HANM Z-BED RECOVERY DESIGN CHANGES

- Replaced 304L and 316 SS with Hastelloy C-276

STAINLESS STEEL 304 & 316 VS. HASTELLOY C-276

Material	%C	%Cr	%Ni	%Fe	Others
304L SS	0.03	19	10	Balance	
316 SS	0.08	17	12	Balance	2.5% Mo
Hastelloy C-276		14.5-16.5	55	7	15-17% Mo, 3-4.5% W

MITIGATION STRATEGIES

- Awareness
- Inspection intervals and periodic non-destructive (NDE) monitoring for areas of concern
- Material Selection
- Reduction of halide concentrations
- Stress Relief

HANM Z-BED RECOVERY DESIGN CHANGES

- Replaced 304L and 316 SS with Hastelloy C-276
- Added heat tracing and insulation on pipe and heating blankets for the Water Traps
- New Pressure Control Scheme

SYSTEM PERFORMANCE IMPACTS

HANM Train 1 Recovery			
Z-Bed (Recovery Dates)	Liters Recovered	Days to Recover	Mag. Beds Consumed
PS-ZA (1/30/2010-2/28/2010)	2,900	28	0.2
RGD A (3/11/2010-4/5/2010)	2,350	24	0.2
RGD B (4/17/2010-6/16/2010)	4,560	59	0.3
P2-ZA (6/25/2010-9/26/2010)	17,940	91	1.4
PS-ZC (10/8/2010-10/28/2010)	4,130	20	0.3
P2-ZC (11/1/2010-1/25/2011)	16,260	84	1.2
Total	48,140	306	3.7

HANM Train 2 Recovery			
Z-Bed (Recovery Dates)	Liters Recovered	Days to Recover	Mag. Beds Consumed
P2-ZB (2/25/2010-6/3/2010)	14,840	98	1.1
PS-ZB (6/12/2010-8/23/2010)	7,680	71	0.6
SS-ZC (8/28/2010-12/1/2010)	9,380	93	0.7
P1-ZA (12/5/2010-3/15/2011)	18,028	100	1.4
Total	41,400	322	3.2

SYSTEM PERFORMANCE AFTER DESIGN CHANGES

Z-Bed (Recovery Dates)	Liters Recovered (STP-L)	Days to Recover	Mg Beds Consumed
P2-ZA (2/6/2012-3/20/2012)	19,198	43	1.9
PS-ZC (3/21/2012-4/1/2012)	4,673	11	0.5
RGD A (4/3/2012-4/9/2012)	1,760	7	0.2
RGD B (4/11/2012-4/21/2012)	2,538	10	0.3
SS-ZA (5/7/2012-5/31/2012)	10,688	27	1.2
P2-ZC (6/17/2012-7/27/2012)	18,432	40	1.8
P1-ZC (7/20/2012-9/9/2012)	20,039	41	1.8
PS-ZA (9/11/2012-9/28/2012)	4,035	18	0.4
P2-ZB (10/2/2012-11/16/2012)	19,605	45	1.8
SS-ZB (12/11/2012-1/23/2013)	15,988	43	1.4
P1-ZB (1/25/2013-2/28/2013)	20,150	34	1.8
Total	137,106	319	13.1

SUMMARY

- Perform NDE and borescope known or susceptible process areas
- Procure halide free equipment and materials placed into the process
- Replace piping that fails with Hastelloy or Inconel
- Design future processes with corrosion resistance