MINUTES
of the
YANKEE DRYER SAFETY SUBCOMMITTEE
OCTOBER 27, 2003
8:30 AM CST

HYATT REGENCY CHICAGO
CHICAGO, ILLINOIS, USA

Present:

Colin Archibald – Scott, Ltd.
Stan Botten – Quality Services Labs, Inc.
Mike Brook – Voith
Clive Butler – Sandusky Walmsley
Bob Byrom – Bender Machine Services, Ltd.
Alan Coons – Potlatch Corp.
Bill Corboy – Yankee Consulting, Inc.
Peter Costello – Kimberly-Clark Corp.
Ron Crawford – Voith
Thomas Davidson – Nexfor Technology
Joel Farnum – Thielsch Engineering
Rich Fearnside – Fearnside Engineering Anal.
Steve Fusco – Mecfab International
Mark Gilkey – FM Global
Tom Grunder – Paperchine, Inc.
James Hickman – Metso Paper
Nancy Hoffman – Mechanical & Materials Eng.
Dwight Hyche – Marsh, Inc.
Jerry Jessick – Georgia-Pacific Corp.
Jerry Kahn – JK Consulting
Doug Kieley – Thielsch Engineering
John Kriedeman – Metso Paper
Larry Ledlow – Hartford Steam Boiler I&I
Jacques Marcotte – BTG Americas
Karl Mayer – FM Global
Mike Paczkowski – BTG Americas
David Parrish – FM Global
Eva Scheideler – Voith
Bill Slatter – Bender Machine Field Services
Truls Snedsbol – Metso Paper
Robert Sullivan – Nat'l Bd. of Boiler & PV I
Brian Tholke – Procter & Gamble Co.
Alf Thunell – Metso Karlstad AB
Bengt Unneberg – Metso Karlstad AB
Dennis White – Inspection Systems & Services

I. Welcome and Statement of Antitrust Policy Compliance

The regular meeting of the Yankee Dryer Safety Subcommittee was called to order at 8:30 AM CST on October 27, 2003 in Chicago, IL, USA by Chairman Bill Corboy.

Bill Corboy reminded those present that the meeting would be conducted in accordance with TAPPI's antitrust policy and procedures:

TAPPI's aim is to promote research and education, and to arrange for the collection, dissemination and interchange of technical concepts and information in fields of interest to its members. TAPPI is not intended to, and may not, play any role in the competitive decisions of its members or their employers, or in any way restrict competition among companies.

II. Approval of Agenda

The agenda was approved as distributed.

III. Approval of Minutes of the May 7, 2003 meeting.

The minutes of the May 7, 2003 meeting were approved as distributed. Motion to approve was made by Dennis White and seconded by David Parrish. Motion passed.

IV. Action Items

There were no action items from the past meeting nor were any action item assignments made at this meeting.

V. Discussion (or Information) Items

A. Subcommittee Membership

James Hickman (Subcommittee Membership) reviewed criteria for becoming a subcommittee member. People are eligible when they attend 2 meetings in a 2-year period. Members get copies of minutes from all meetings thereafter, whether they attend or not. To maintain membership, you must attend 1 meeting every 2-year period afterwards.

Guests always get a copy of the minutes of the meeting that they attended, as well as agendas and invitations to future subcommittee meetings.

B. 2003 Fall Technical Conference – Yankee Dryer papers

Bill Corboy informed the attendees that the Yankee Dryer Safety Subcommittee had sponsored 5 technical papers to be presented at 2 sessions at the 2003 Fall Technical Conference. Attendance to the presentations and copies of the Proceedings require a separate Conference registration and fee. Papers that were presented:

- *Survey of Yankee Dryers and Machine Glazed Cylinders*
  – Brian Tholke, Procter & Gamble Co.
- *Risks Associated with Hot-Work Repairs On and Near Yankee Dryers*
  – Bill Corboy, Yankee Consulting, Inc.
- *A Study of the Induced Stress Caused by a Single Plug in a Yankee Dryers Shell Whilst Under Normal Operating Conditions*
  - Peter Costello, Kimberly-Clark
- *A "First Look" at Yankee Dryer Warm-up Induced Stresses*
  - Rich Fearnside, Fearnside Engineering Analysis
- *Yankee Dryer Safety Training Series*
  - Alan Coons, Potlatch Corp.

C. NBIC Yankee Dryer Appendix K

Brian Tholke presented information on the new NBIC Appendix K that was recently approved by the Code Committee of the National Board of Boiler and Pressure Vessel Inspectors. Brian discussed the reasons and goals for starting the work, the formation of an NBIC task group, and the initial version of the Non-mandatory Appendix K for Yankee Dryers.

The document will be continually reviewed and revised in the future. Dave Parrish is leading the effort to re-submit TAPPI recommended guidelines for limiting the amount of smooth driven plugs in a Yankee Dryer shell. Proposed changes were shared with the subcommittee and comments are welcome and should be sent to Dave Parrish by mid-November. Brian Tholke will make sure that all subcommittee members receive the proposed change by November 1, 2003.

For further information – see the Attachments.

D. Yankee cracking incident

Dave Parrish discussed a recent Yankee Dryer incident. The dryer was inspected internally on all areas that were machined and/or subject to high stresses using Wet Fluorescent Magnetic Testing (WFMT). Two indications were found. One was at the bolt stop area where the journal bolts with the head. The other area was in the flange of the journal/centershaft joint in the center of the Yankee Dryer.

The first indication was relatively short in length. It was ground to determine the depth of the defect. The defect proved to be less than 1/8 inch deep. This area of the head carries little stress. The defect was considered trivial and repaired by grinding.

The second indication was 3 inches long in the flange face. It extended from under a nut towards the centershaft-to-flange radius. The defect showed up with WFMT inspection, but did noi show up when using Penetrant Testing (PT) until after the crack had been lightly ground. The nut was removed and WFMT showed that the indication did not extend into the bolt hole itself. The indication was removed by grinding. The defect was removed after grinding away 3/8 inches of metal. When grinding the defect away, casting porosities were opened indicating that the crack was probably related to initial casting defect and not due to field operation.

For further information – see the Attachments.

E. Acoustic Emission: Data trends & defects

Dennis White shared information on AE plots (energy versus amplitude) of various types of Yankee Dryer defects encountered over the years. Examples included steam leaks, metal thermal spray delamination, shell impact damage, cracked structural bolts, etc.

For further information – see the Attachments.

F. Yankee shell crack & steam leaks

Bill Corboy shared information on a Yankee Dryer that was recently replaced. The old dryer had numerous design issues, shell cracks and steam leaks. The dryer had minimal documentation of manufacture and shop inspections. The shell taper section was very short, there was minimal clamping force at the Head-to-Shell joint, and the Shell flange OD had a sharp corner instead of an edge break.

Steam leaks at the Head-to-Shell joint were noted shortly after startup. Pumping bolts were installed and sealant was pumped into the joint. Inspection revealed that a gasket was missing from the joint. Bolts were pumped several times over the next few years.

A plug repair was noted near the shell flange OD. The edge of the paper was very close to the shell edge and there was heavy application of water on the shell edge. AE activity was noted from the shell flange area. Numerous bolts were steam-cut and were cracked. Shell bolt stop samples were removed and the microsturcture was evaluated. The shell had a high percentage of carbides. The graphite was poorly formed in the cast iron.

Steam leaks and sealant pumping continued Numerous bolts were replaced due to steam cutting and cracking. Operating steam pressure was reduced from 8 bars to 2.5 bars. The mill was advised to purchase a replacement dryer as soon as possible and this was installed several months later.

One lesson is that the Yankee Dryer purchaser should have been given proper documentation and inspection information by the manufacturer. Another lesson is that application of modern inspection techniques allowed the suspect dryer to be carefully monitored and operated even though it was in a deteriorating condition.

VI. New Business

A. Open Discussion

Larry Ledlow asked about metal stitching as a repair technique for Yankee Dryers. A TAPPI Yankee survey on metal stitching (September 2002) was reviewed. This indicated that the majority of people had concern with this technique especially if used on a shell crack. The defect location, the defect size, and stress levels all have a bearing on whether metal stitching was considered for use. Some companies have operated dryers with metal stitched shells but only when accompanied with operating pressure reductions and extra-frequent AE monitoring.

People commented on the need for better information to be transferred from the TAPPI committee to industry and to owners and operators of Yankee Dryers. Small-sized companies do not have the resources for staff experts and normally are not active in TAPPI. There is a need to get technical information to them. The officers will work on establishing mailing lists to inform these companies of upcoming meetings.

VII. Next Meeting

The next meeting will be held in the March-April-May 2004 time-frame. Meeting notice will be sent out at least 2 months in advance, and an agenda will be distributed before the meeting.

VIII. Adjournment

There being no further business to come before the Yankee Dryer Safety Subcommittee, the meeting was adjourned at 10:55 AM CST. Motion to adjourn was made by Larry Ledlow and seconded by Clive Butler. Motion passed.

Minutes submitted by: Brian Tholke

Approved by: Laura Feix

Attachments:
1. PDF file – Tholke - NBIC Yankee Appendix K
2. PDF file – Parrish - Yankee cracking incident
3. PDF file – White - Acoustic Emission: Data trends & defects
4. PDF file – Corboy - Yankee shell crack & steam leaks

NBIC Non-mandatory Appendix K Inspection, Repairs and Alterations for Yankee Dryers

- Why we got started on this activity
- Building on TAPPI resources
- Where we are today
- NBIC Appendix K - Highlights

Why we got started on this activity

- Questions about how to :
  - plug repair Yankee shell
  - metallize shell surface
  - seal joint steam leaks
  - inspect head/shell joint
  - ASME Local Thin Area Code Case

Why we got started on this activity

- Wanted A.I.s to better understand accepted industry practices for inspection & repair of Yankee Dryers.
- Wanted other Yankee owner/operators to better understand accepted industry practices for inspection & repair.

Building on TAPPI resources

- TAPPI Yankee Dryer Safety Subcommittee has diverse experience and representation by:
  - Owners/Operators
  - Suppliers/Consultants
  - Insurers

Building on TAPPI resources

- TAPPI Yankee Dryer Safety Subcommittee has published:
  1. Guidelines for the Safe Operation of Yankee Dryers
  2. Yankee Dryers: Guidelines for Safety & Condition Assessment
  3. Technical papers that were presented at TAPPI Engineering Conferences & at Tissue World

Building on TAPPI resources

- TAPPI Yankee Dryer Safety Subcommittee decided that the best way forward was to write Yankee-specific code requirements for the National Board Inspection Code.

  (December 2001)

Building on TAPPI resources

- Why the NBIC?
  - NBIC is for inservice inspection and repair
  - ASME PV Code is for new construction

Building on TAPPI resources

- Why the NBIC?
  - Purpose of NBIC is to “maintain the integrity of pressure retaining items after they have been placed into service by providing rules for inspection, repair and alteration, thereby ensuring that these objects may continue to be safely used.”

Where we are today

- We formed an NBIC Task Group which consisted of TAPPI members and NBIC Code committee members.
- We published several rough drafts.
- A proposed Appendix submitted to the NBIC.
- Public Comments were made to the Appendix.
- Comments were resolved by NBIC Appendix Subcommittee and Committee, and Appendix was approved for publication as part of 2003 Addenda.

NBIC Appendix K
K-1000 Inspection

- Defined characteristics of a Yankee Dryer (YD).
- Defined the various stresses on a YD.
- Established the concept of the “De-rate Curve”.
- Established ribbed shells (effective thickness).
- Discussed causes of deterioration & damage.
- Routine-periodic inspection to be performed, at a minimum, of once every 2 years.
- Established AE as preferred pressure test method in the field.

NBIC Appendix K
K-2000 General Requirements for Repairs & Alterations

- Recommended additional YD NDE methods such as AE for crack detection and metallographic examination for microstructure changes.
- Defined allowable operating parameters and stresses, ASME Primary Membrane Stress, and criterion for ASME principal stress and fatigue stress.
- Established that Stamping is not required after a shell grind provided the “De-rate Curve” is still used for controlling max. operating parameters.

NBIC Appendix K
K-3000 Yankee Dryer Repair Methods

- Emphasized that YD components are castings and that welding or brazing shall not be used.
- Defined examples of YD repairs such as:
  - Shell grinding
  - Journal grinding
  - Head/Shell joint corrosion removal
  - Metallizing
  - Head flange OD reduction
- Defined process / procedure for treatment of:
  - crack-like flaw
  - local thin area (LTA)

NBIC Appendix K
K-4000 Alterations to Yankee Dryers

- Defines typical YD alterations such as:
  - Enlarging bolt holes in castings to accommodate larger diameter bolts.
  - Operating above the nameplate temperature.
  - Replacement of structural bolts differing in size, material, or design from those described on Form U-1A Manufacturer’s Data Report.

NBIC Appendix K Contributors

- Special thanks for their effort, dedication and time spent in meetings to the TAPPI Task Group:

- Clive Butler
- Bill Corboy
- Pete Costello
- James Hickman
- Larry Ledlow
- Karl Mayer
- Dave Parrish
- Michael Schindler
- Brian Tholke
- Jack Wells
- Dennis White

NBIC Appendix K Contributors

- Special thanks for their effort and dedication to the following NBIC committee members:

- John Engelking
- Pete Hackford
- Craig Hopkins
- Herb Staehr
- Robert Sullivan
- Chuck Withers

NBIC Appendix K – the Future

- Appendix K will be revised & reviewed periodically.
- Process for review of proposed changes will be the same as that followed for the initial acceptance of the document.
- Dave Parrish has volunteered to submit the next proposed change regarding plug repairs.
- All future changes will be commented on by the TAPPI Task Group. Information will be shared with the TAPPI subcommittee.

Appendix K - Proposed Change

Shell surface imperfections may be repaired with smooth, driven plugs as described in ASME Section VIII, Division 1, UCI 78, with the following additional requirements:

Maximum plug length (depth) limited to 20% of shell effective thickness, and plug diameter not exceeding the plug length (depth).

Total surface area of plugs not to exceed 4 square inches in an 8 inch diameter circle (2580 sq. mm in a 200 mm diameter circle).

Average number of shell plugs not to exceed 1 per 1 square foot (1 per 0.1 sq. meter) of the shell surface.

Appendix K - Proposed Change

The land distance between edges of plugs at least equal to the diameter of the larger plug.

The plug material shall conform in all respects to the material specification of the base material.

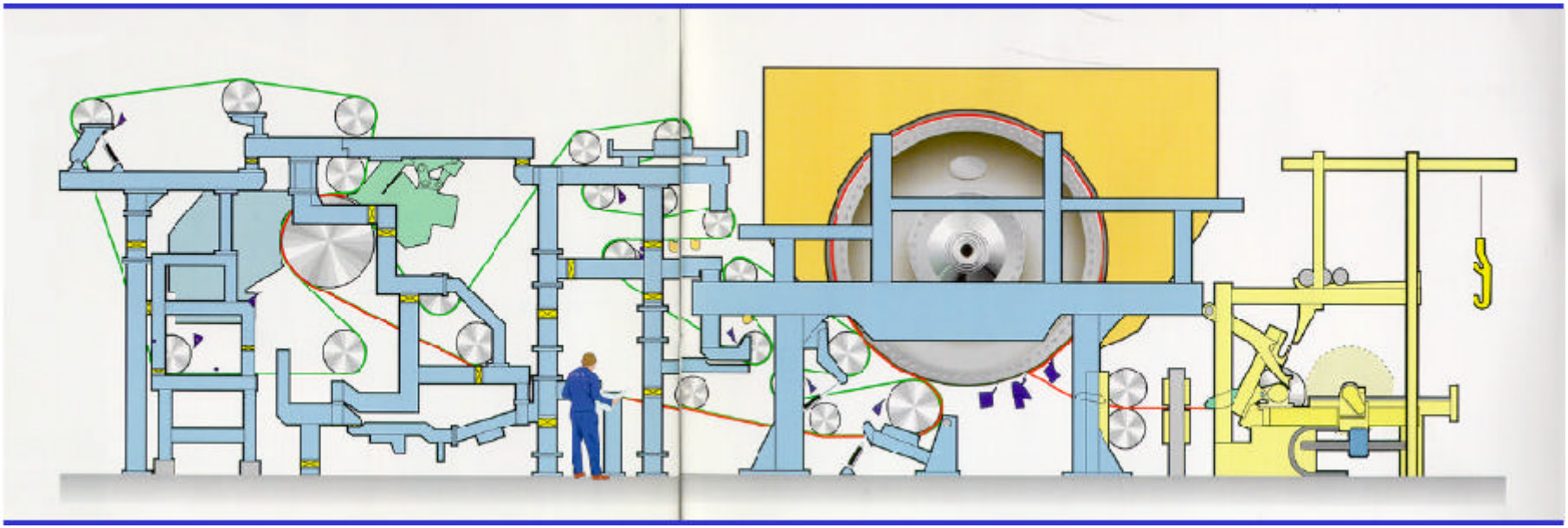
The installed plug shall have an interference fit. The average hole diameter is determined after the plug hole is drilled and reamed. The maximum plug diameter should not exceed 1.012 times the average hole diameter. This provides an interference fit while minimizing the residual stresses.

Questions ?

Yankee Cracking Incident

YDSSC

October 27, 2003



Dave Parrish

Yankee Cracking Incident

MG cylinder was manufactured in 1994.

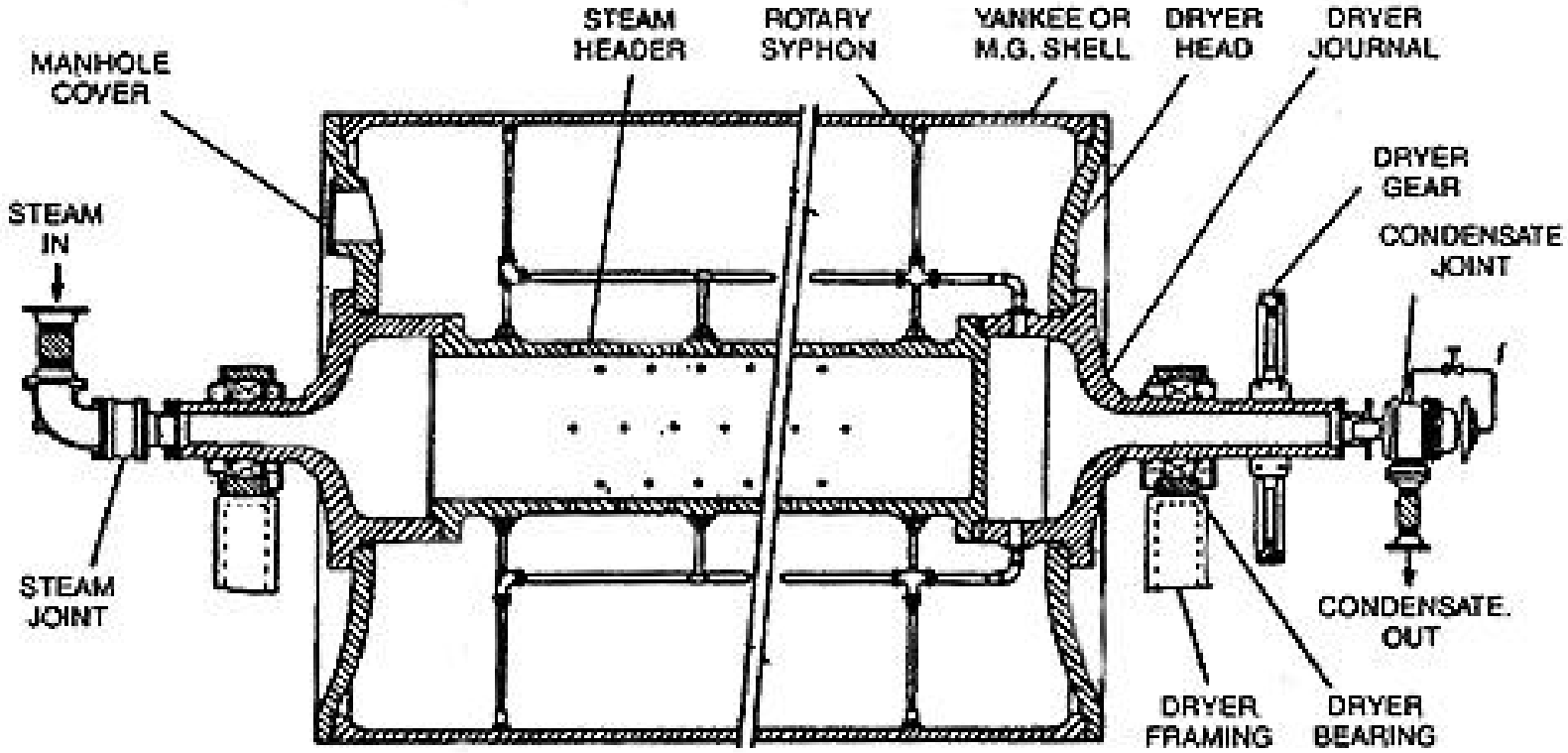
The operating specifications were:

- max. nip load of 350 pli (61 N/mm)
- max. speed of 1500 fpm (492 m/min.)
- max. pressure of 125 psig
- max. temperature of 450°F

This dryer operating conditions are:

- nip loading of 275 pli
- speed of 1200 fpm
- pressure at 125 psig (safety relief valve setting)
- temperature at 354°F (saturated steam at 125 psig)

Yankee Cracking Incident



The Yankee shell ID and OD was inspected by Wet Fluorescent Magnetic Testing (WFMT) for linear indications in September 2001. None were found.

The heads were not tested due to a lack of time.

Yankee Cracking Incident

On August 7, 2003 the mill opened the dryer for an internal inspection and WFMT of all high stress areas.

The areas on the insides and outsides of the heads and shell that could be susceptible to cracking were blast cleaned with bicarbonate of soda.

Two indications were found.

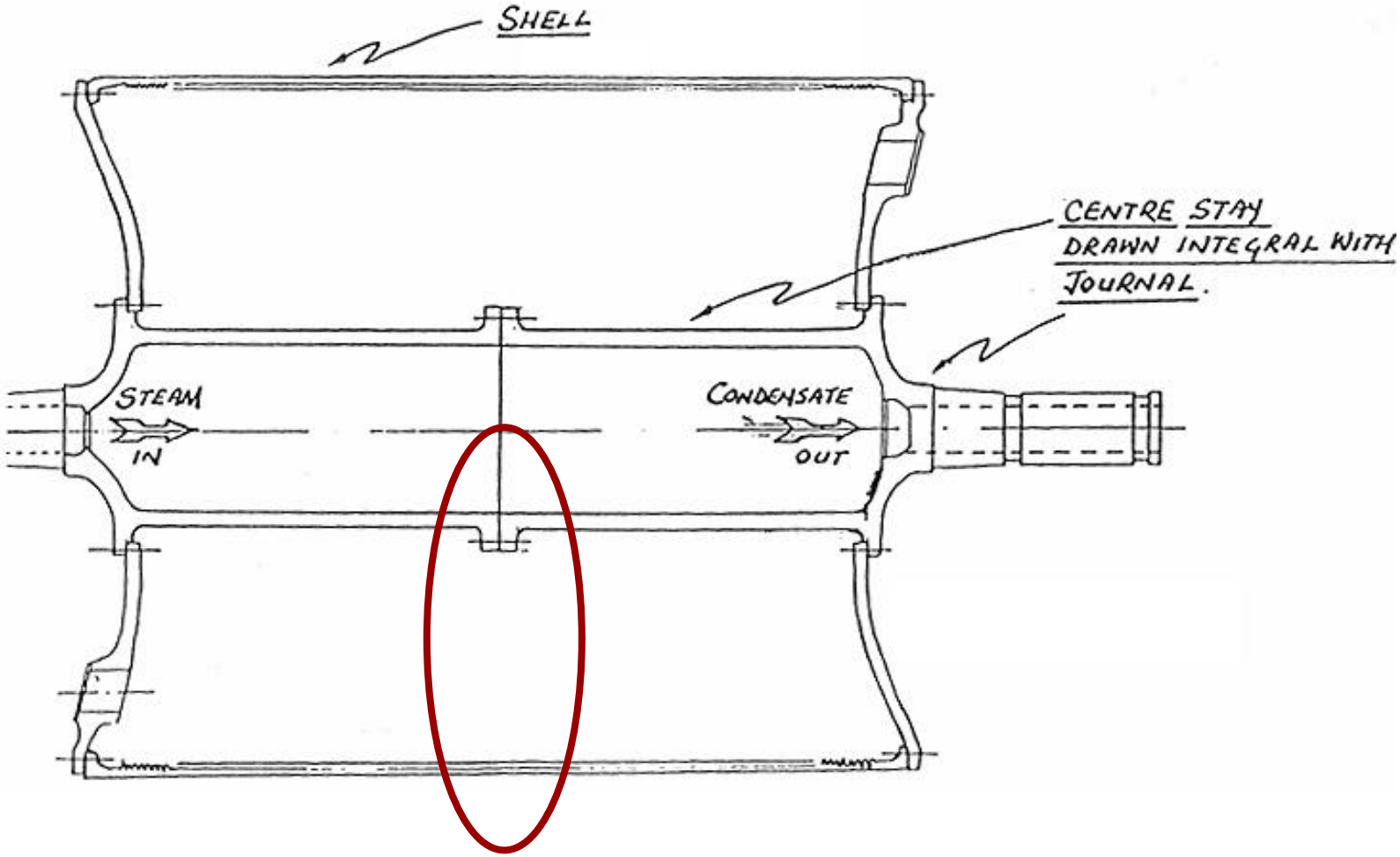
Yankee Cracking Incident

The first indication was 1/4" long and in the corner of the internal nut stop flange for the center stay on the front head. The indication was blended out by grinding and proved less than 1/8" deep.

This is an area of the head that carries very little stress.

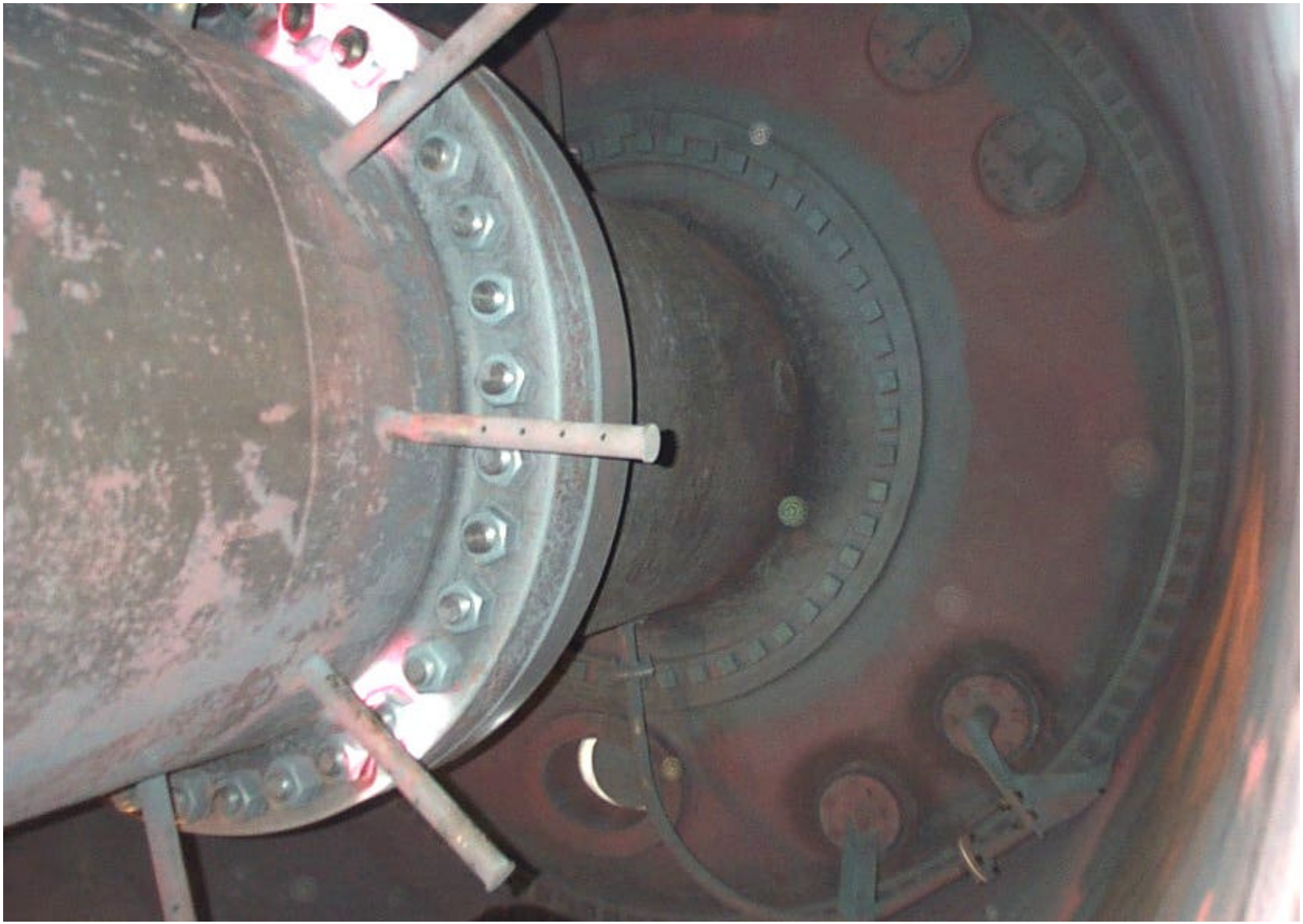
The flaw was considered trivial.

Yankee Cracking Incident



The second indication was in the central flange of the front half center stay.

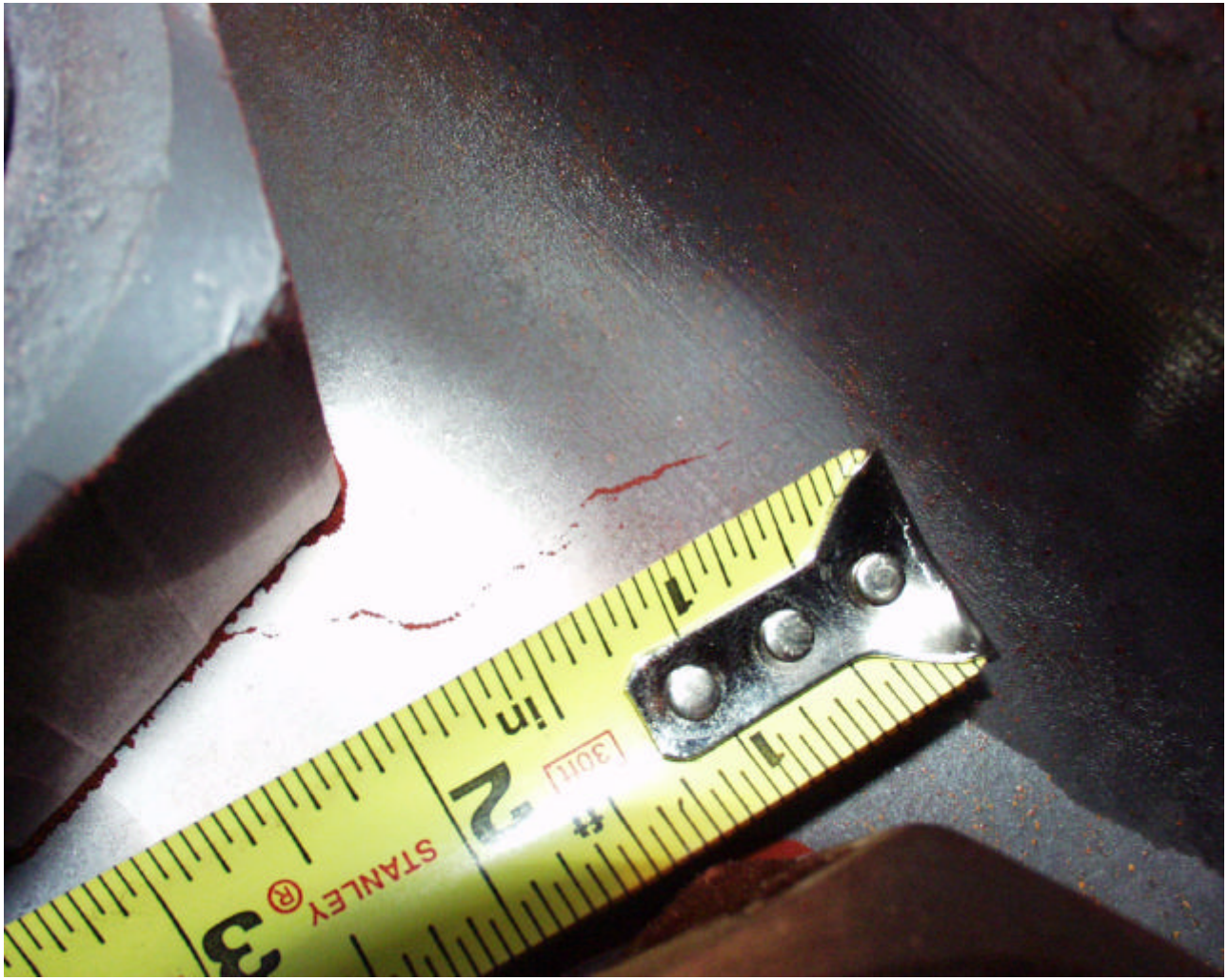
Yankee Cracking Incident



Yankee Cracking Incident

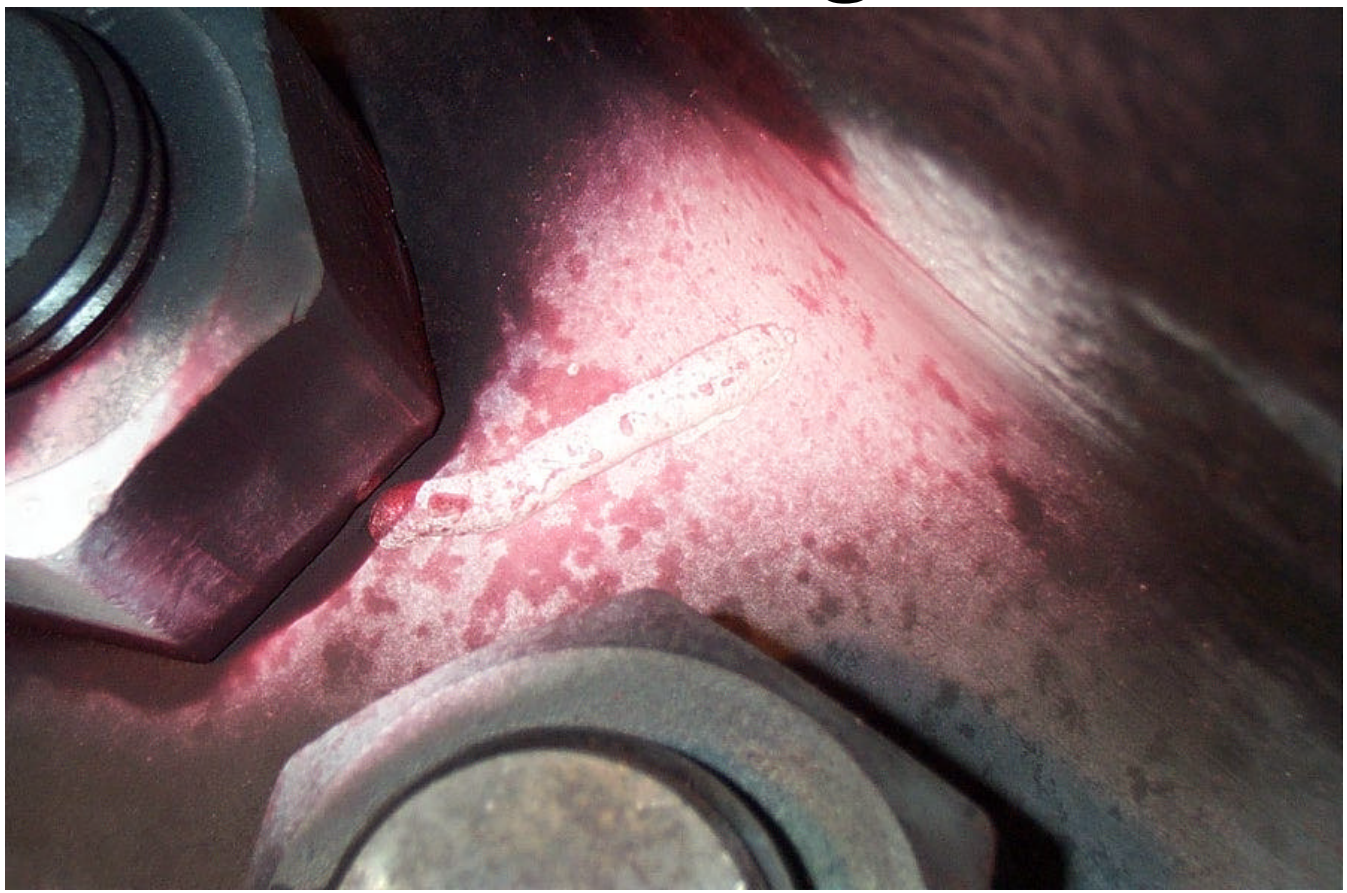
Based on its orientation, the second indication did not appear to be stress related. The end of the indication was marked and the MG Cylinder put back into service until another down day would allow further analysis.

Yankee Cracking Incident



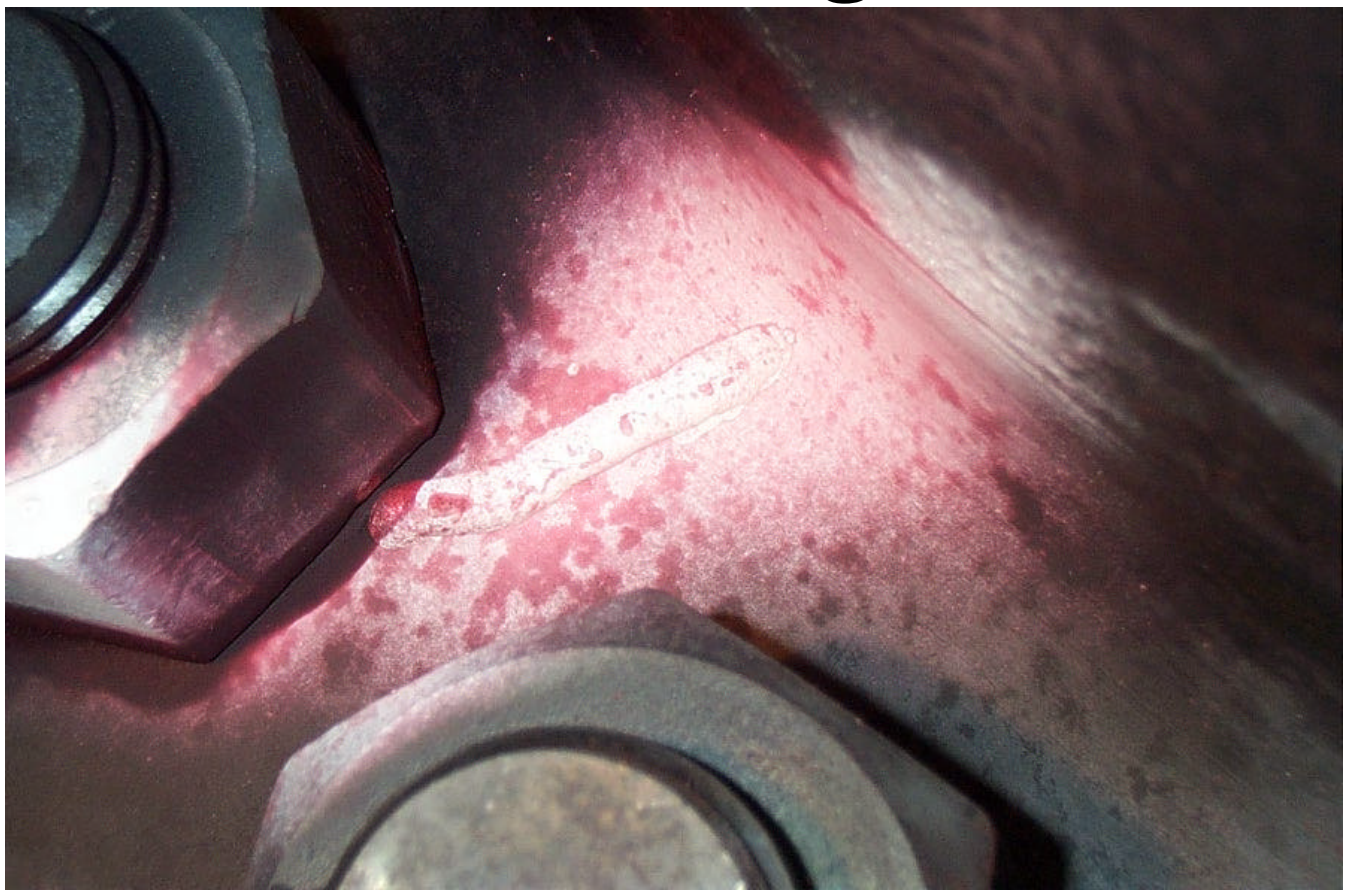
The second indication was 3" long and extended from near a bolt hole towards the flange to shaft radius of the center stay.

Yankee Cracking Incident



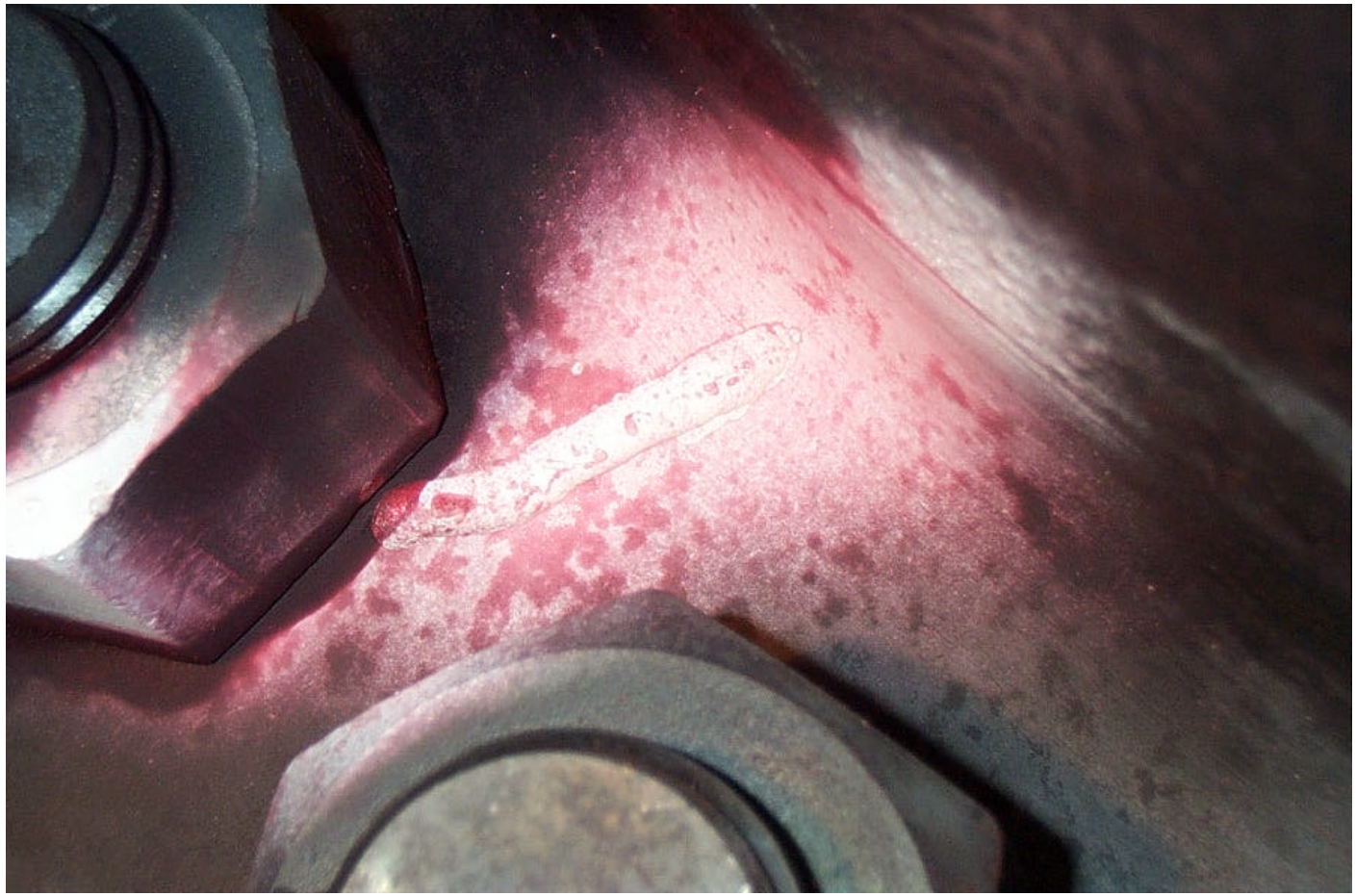
Initial testing on August 27th was done with dye penetrant (PT) rather WFMT. The indication was extremely tight and could not be revealed with PT but showed up when WFMT was used.

Yankee Cracking Incident



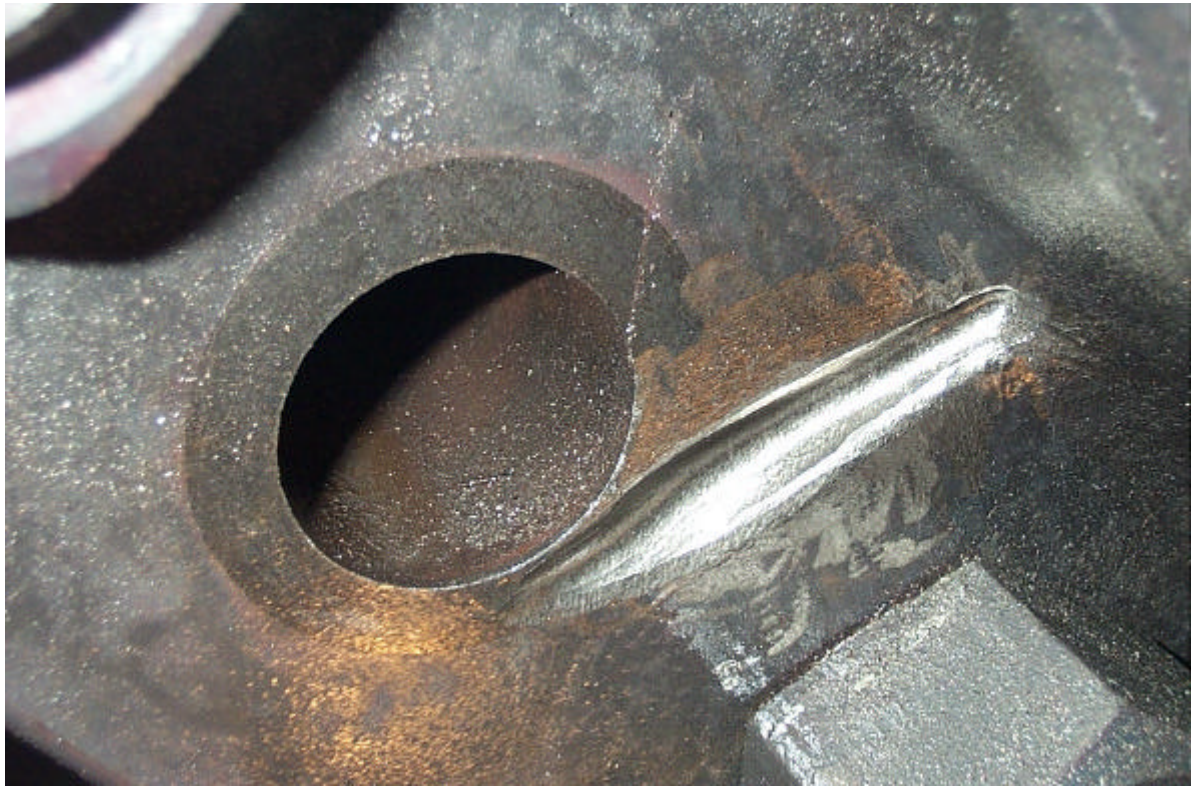
A light grind to 3/16th of an inch was made.
The indication showed tails and side indications with WFMT.
Now PT did reveal some of the indication.

Yankee Cracking Incident



On August 28th the bolt was removed from the hole.
WFMT disclosed the flaw did not involve the hole.

Yankee Cracking Incident



The second indication was removed by grinding. It was removed and proven gone with WFMT at a depth of only 3/8". This left a 3" long by 3/8" deep, smoothly blended excavation in the 5" thick flange. The excavation will be examined with WFMT during the next outage to make sure that the indication does not reappear.

Yankee Cracking Incident

Summary:

While grinding out the second indication, the grinder encountered pockets of "inclusions". These foundry inclusions were probably the origin of the flaw.

The orientation of the flaw suggests that it is not a service related crack.

So both indications are considered resolved and the MG Cylinder is considered clear of indications.

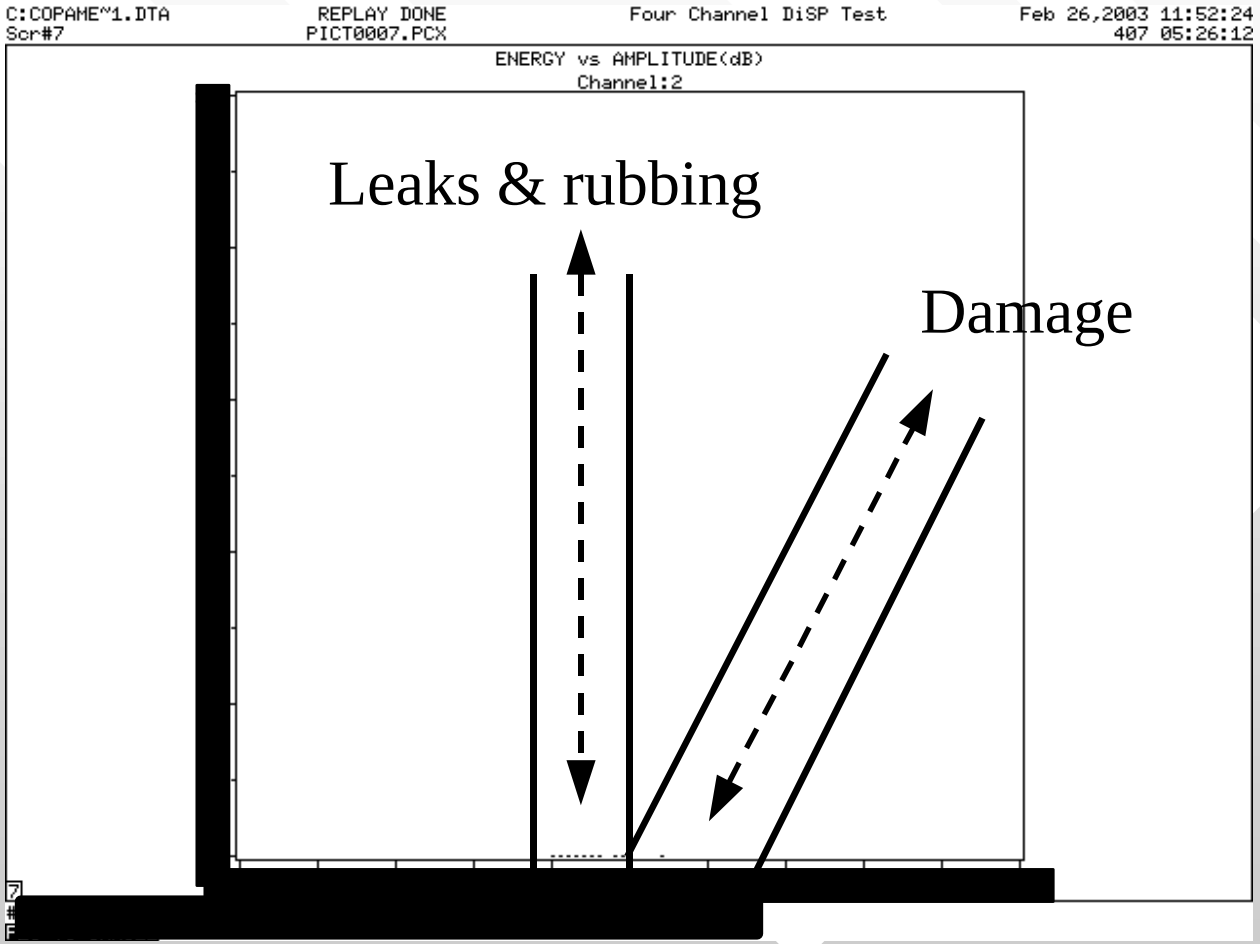
The next examination will be in a year.

Acoustic Emission: Data Trends and Defects

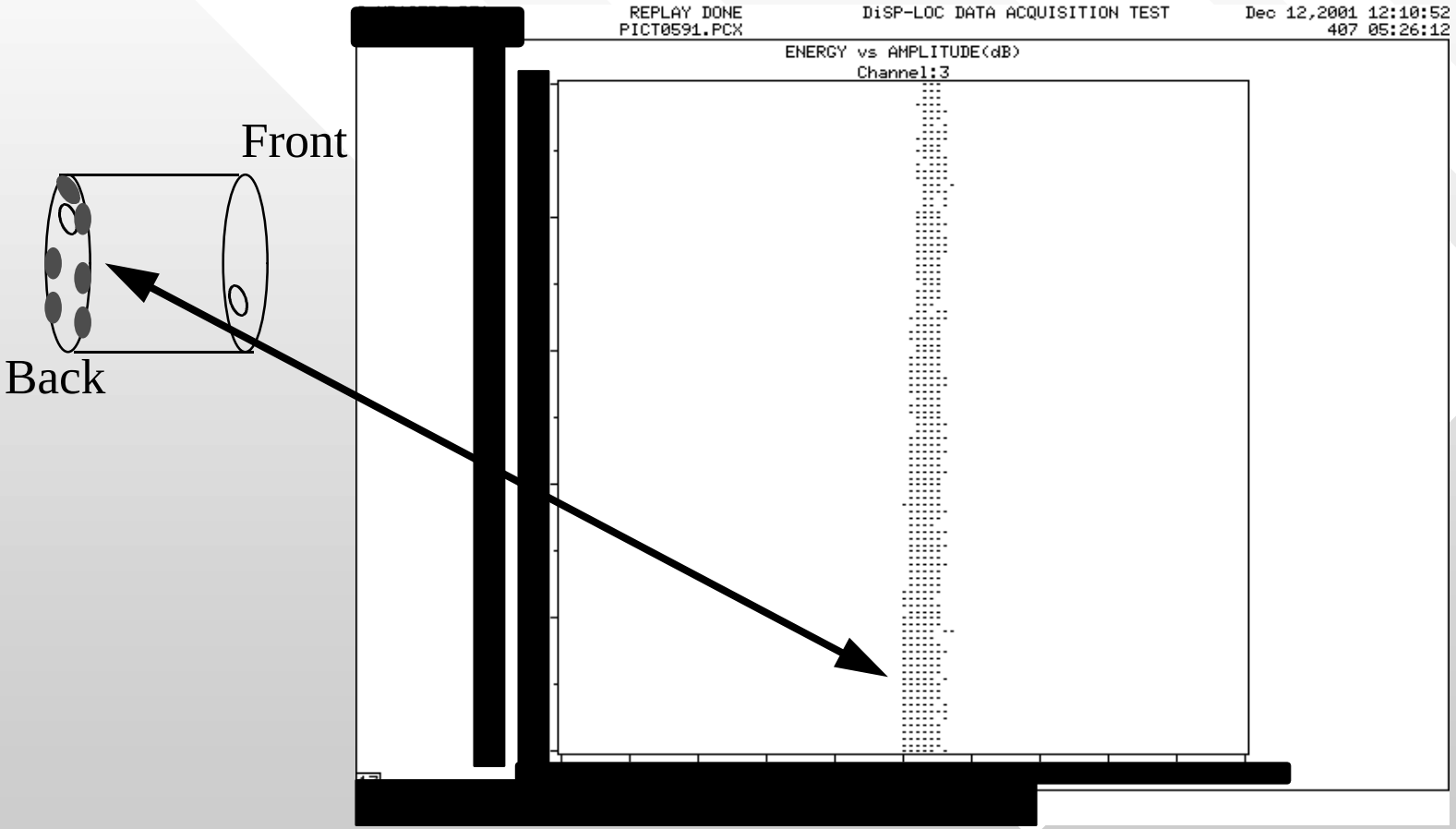
Dennis White
Inspection Systems and Services
St George Island, FL

dwhite@gtcom.net 850-927-3487

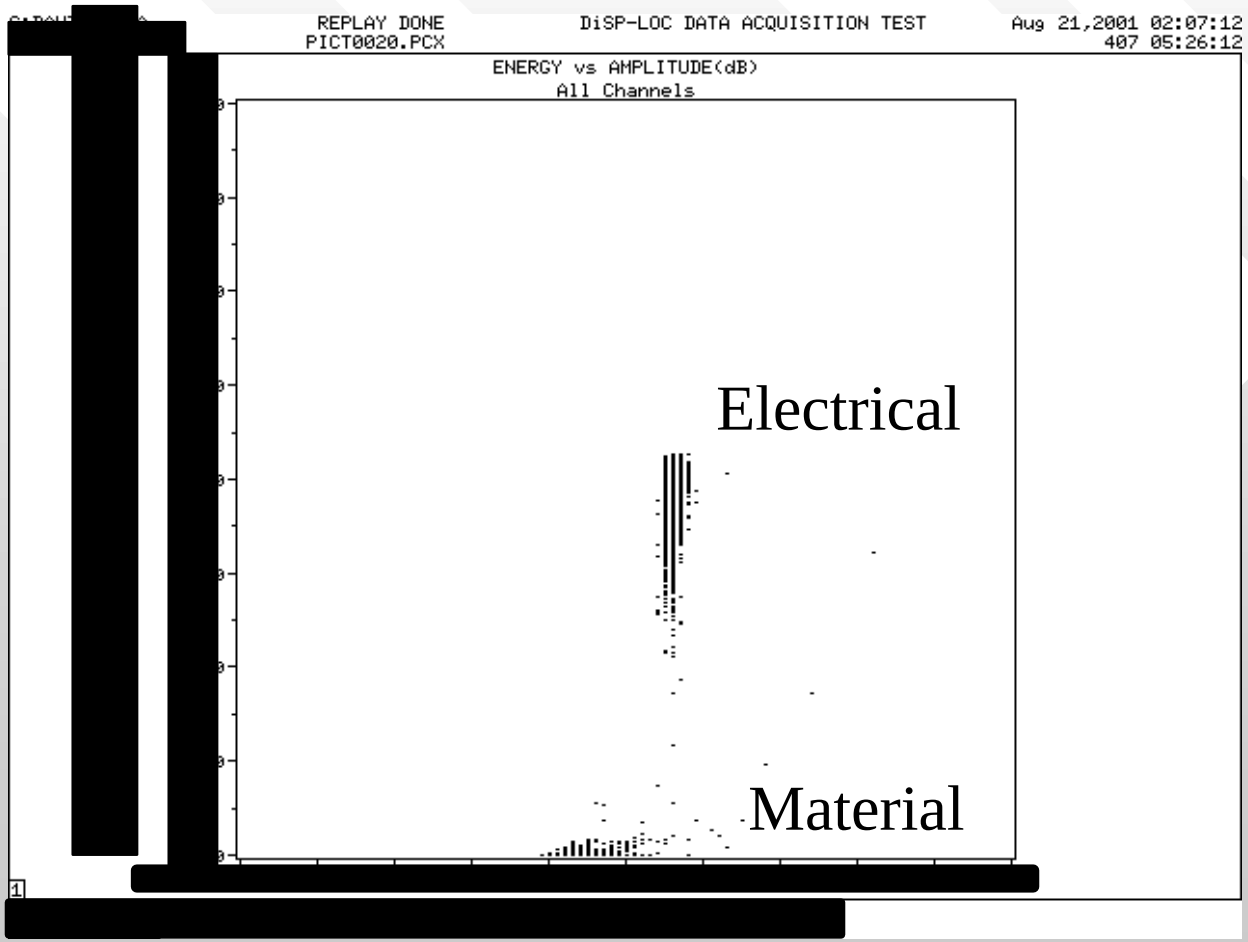
Two Simple AE Data Trends



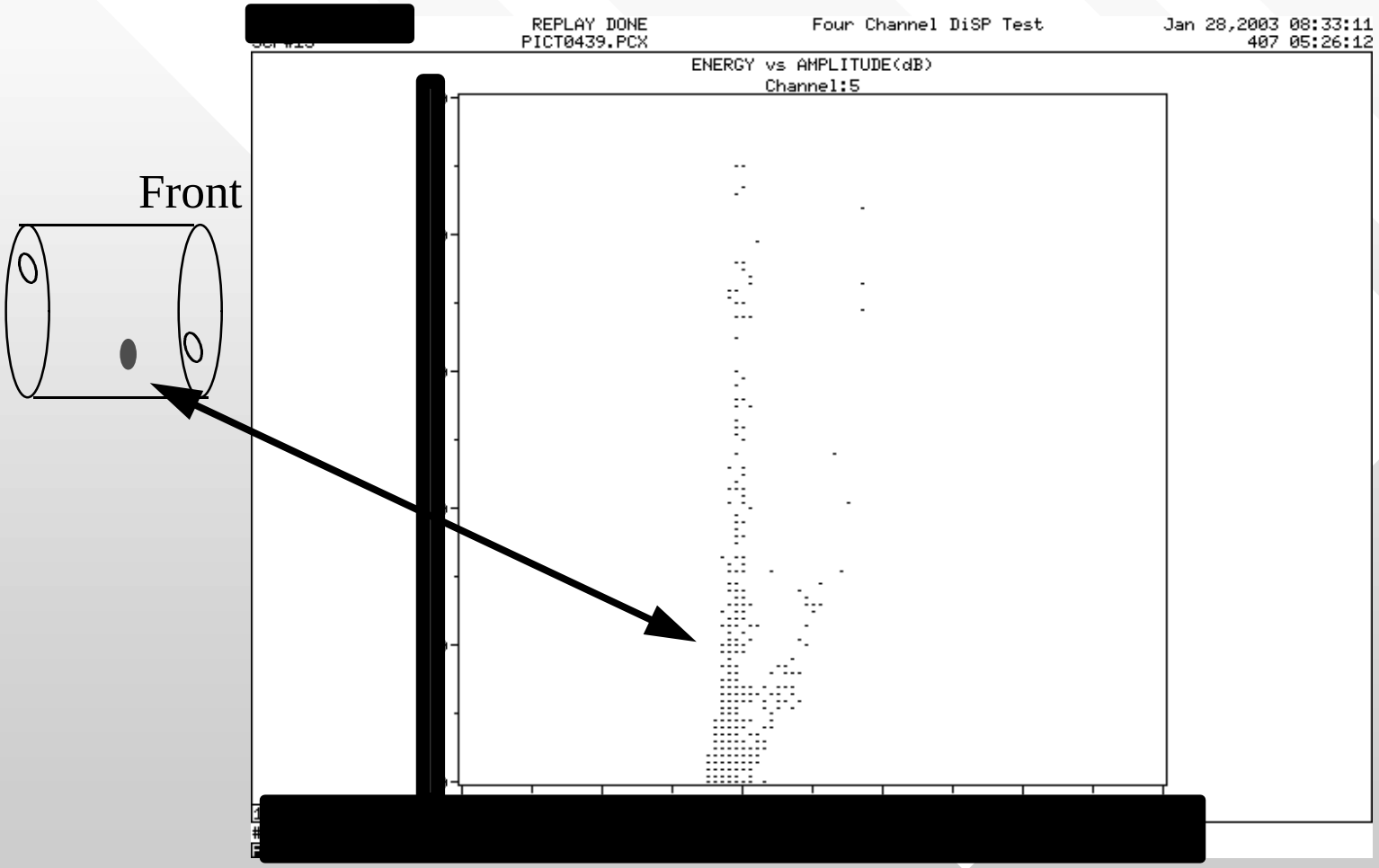
Steam Leak


REPLAY DONE
PICT0591.PCX
DiSP-LOC DATA ACQUISITION TEST
Dec 12,2001 12:10:52
407 05:26:12
ENERGY vs AMPLITUDE(dB)
Channel:3
Front
Back

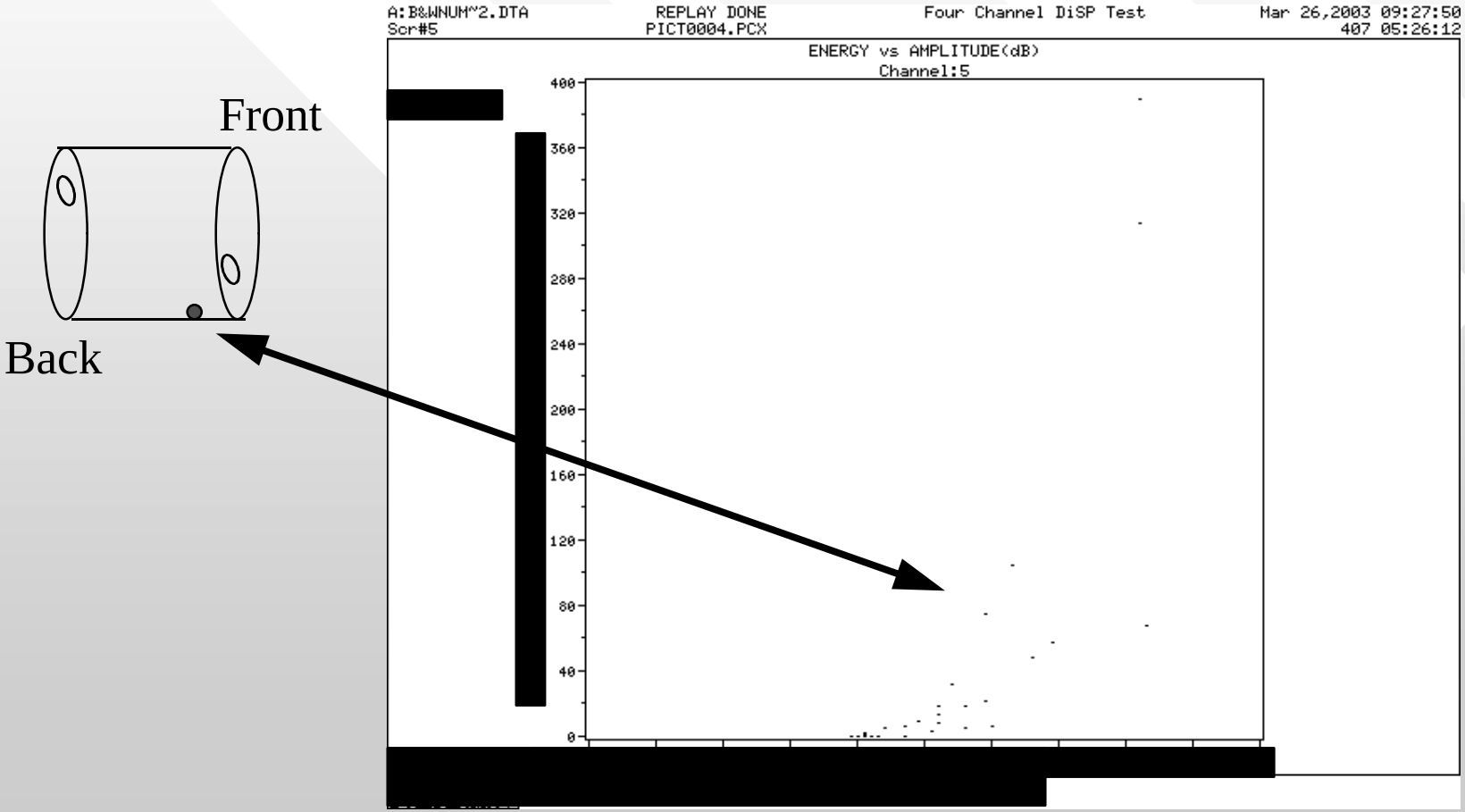
Electrical resonances with material data



Metal Spray Delamination

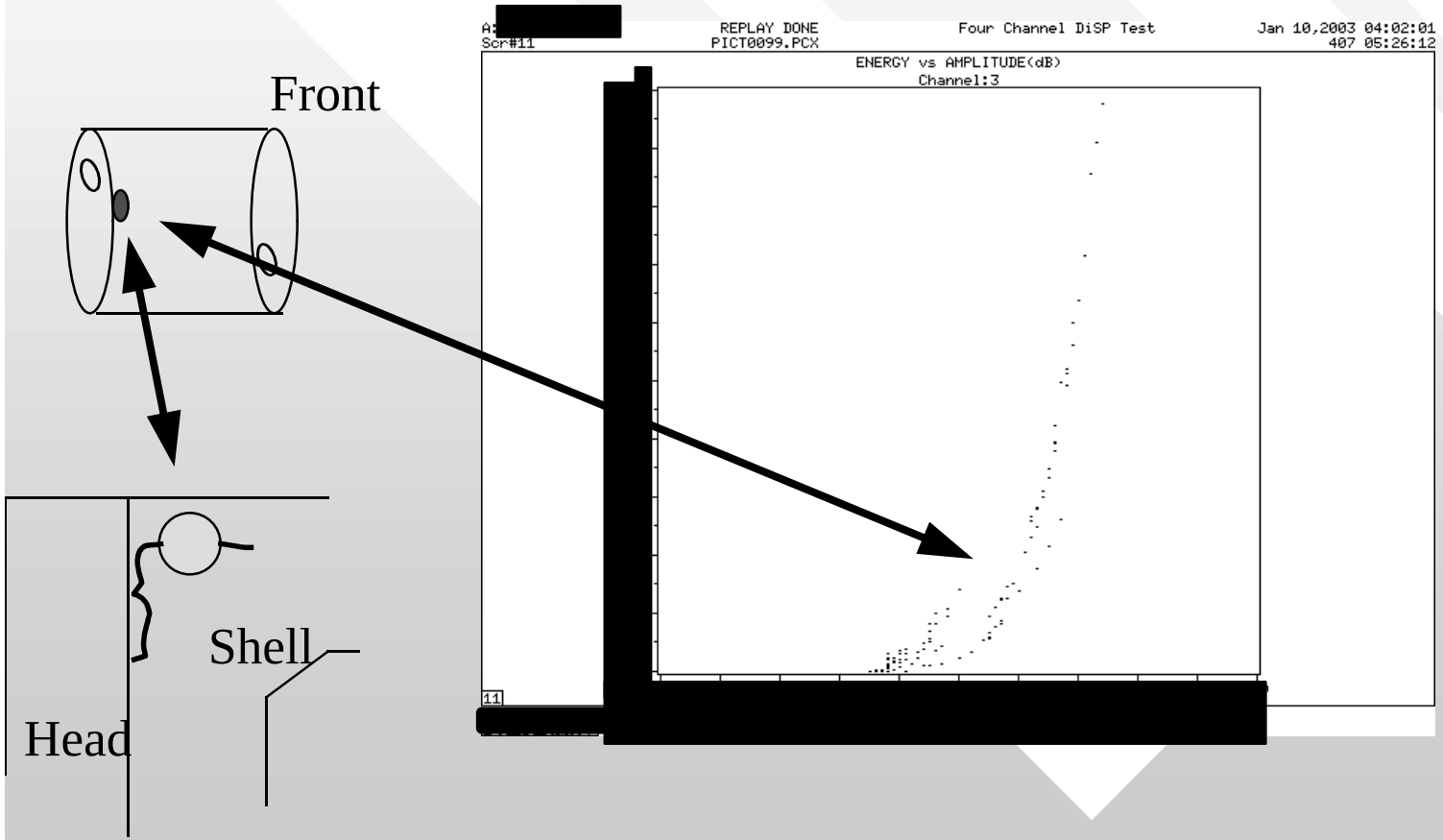


Dryer B: 3 Cracks, 1/8” long x 1/32” deep
Header bracket attachment hole on ID rib
(30 min)

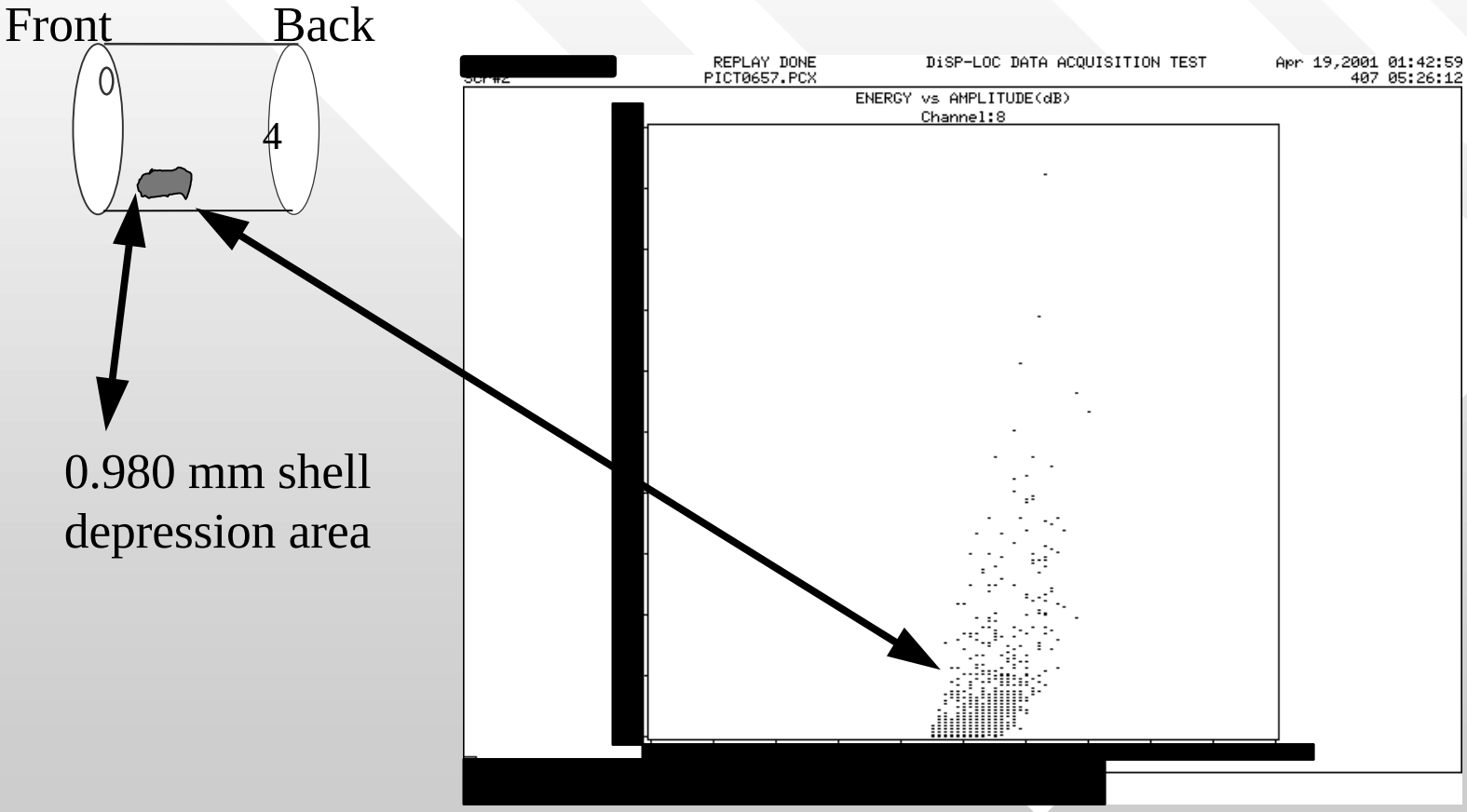


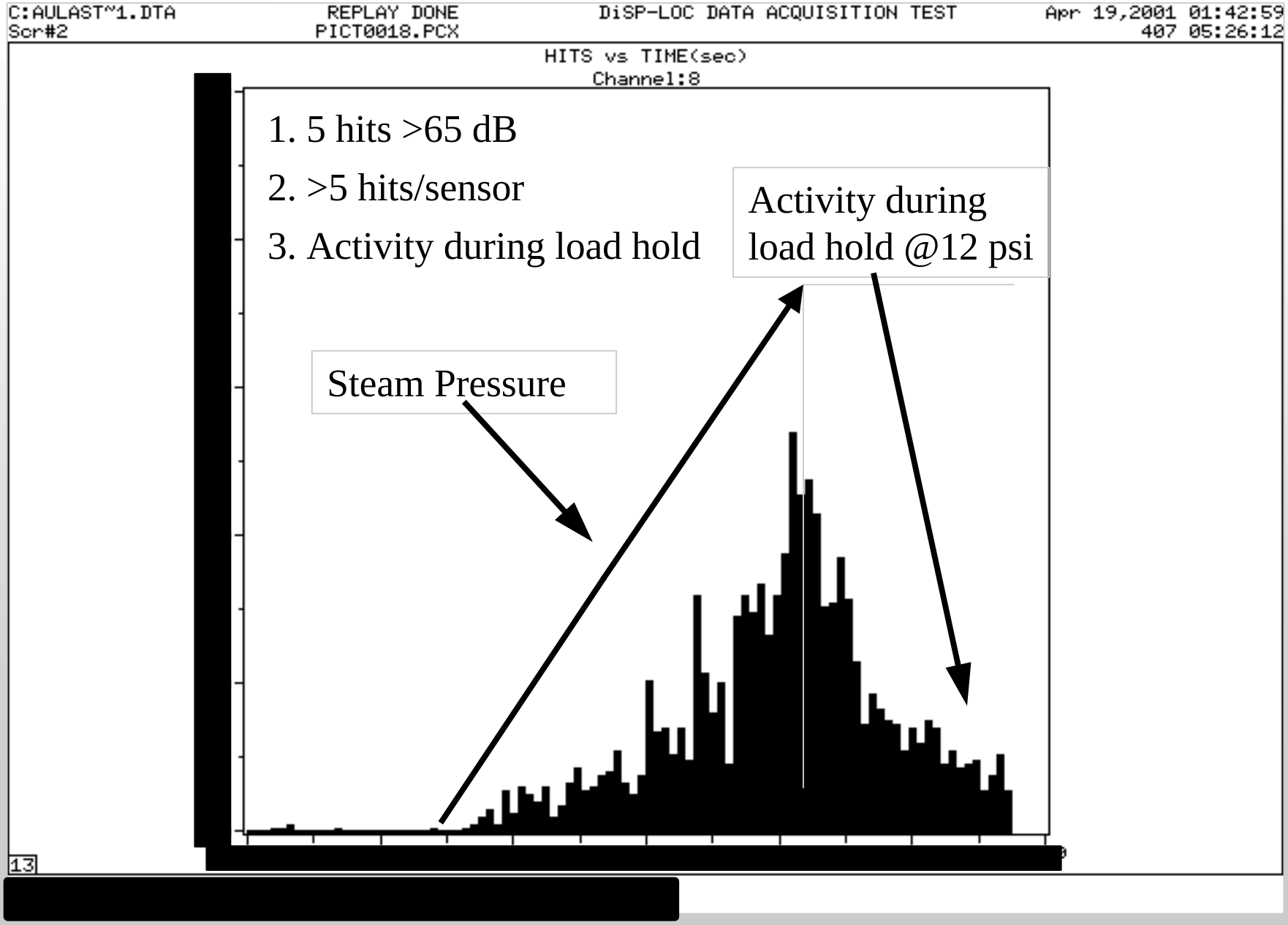
Dryer C: 2 cracks, length ~1”

~¾” on one side & ~1/4” either of shell plug (30 min)

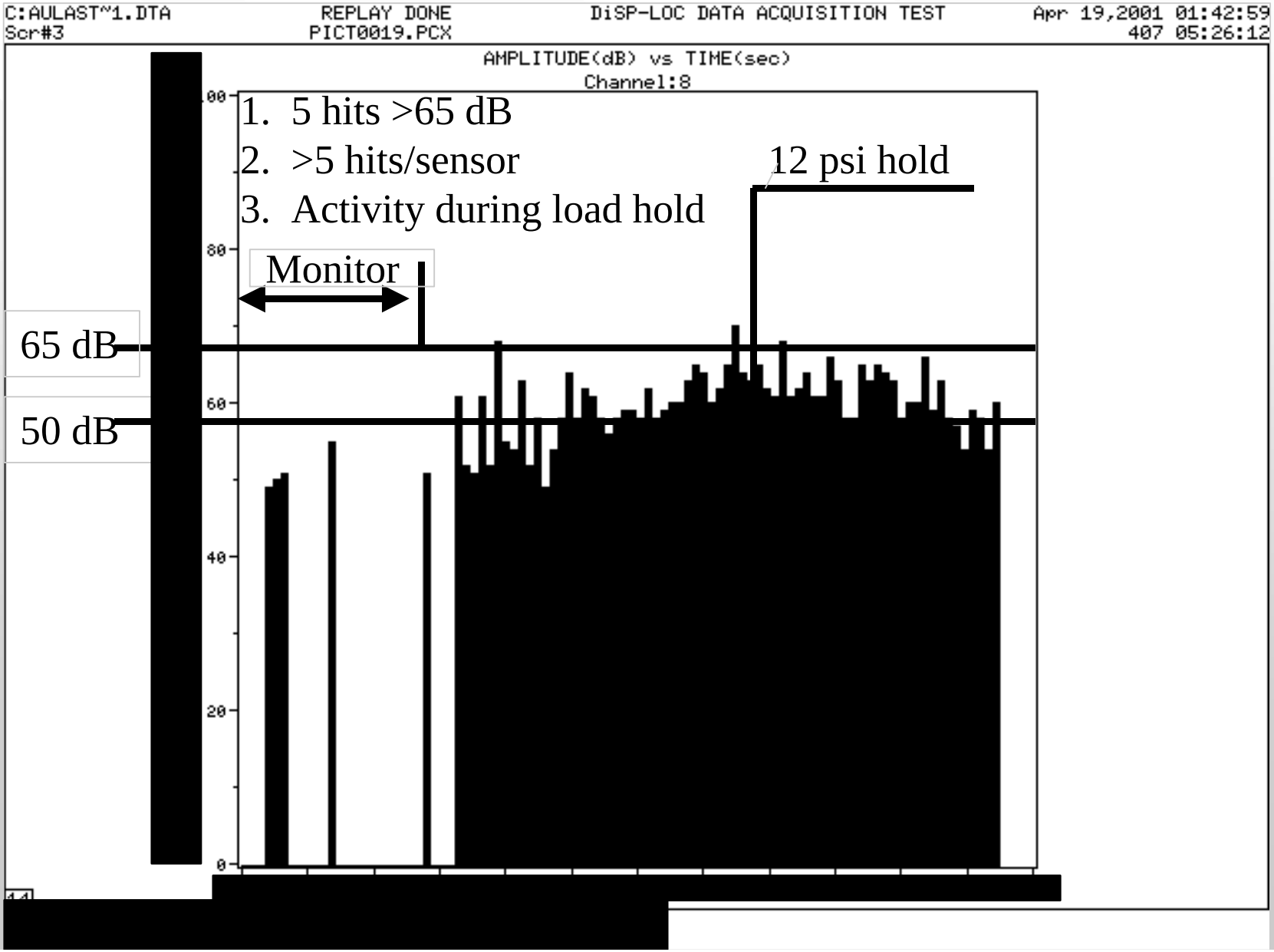


Dryer D: O.D. Shell Crazing
Impact Damage AE data to 0.8 bar (<20 minutes)




C:AULAST~1.DTA
Scr#2
REPLAY DONE
PICT0018.PCX
DiSP-LOC DATA ACQUISITION TEST
Apr 19,2001 01:42:59
407 05:26:12
HITS vs TIME(sec)
Channel:8
1. 5 hits >65 dB
2. >5 hits/sensor
3. Activity during load hold
Activity during load hold @12 psi
Steam Pressure
13

Histogram plot of max. sensor hit Amplitude vs. Time

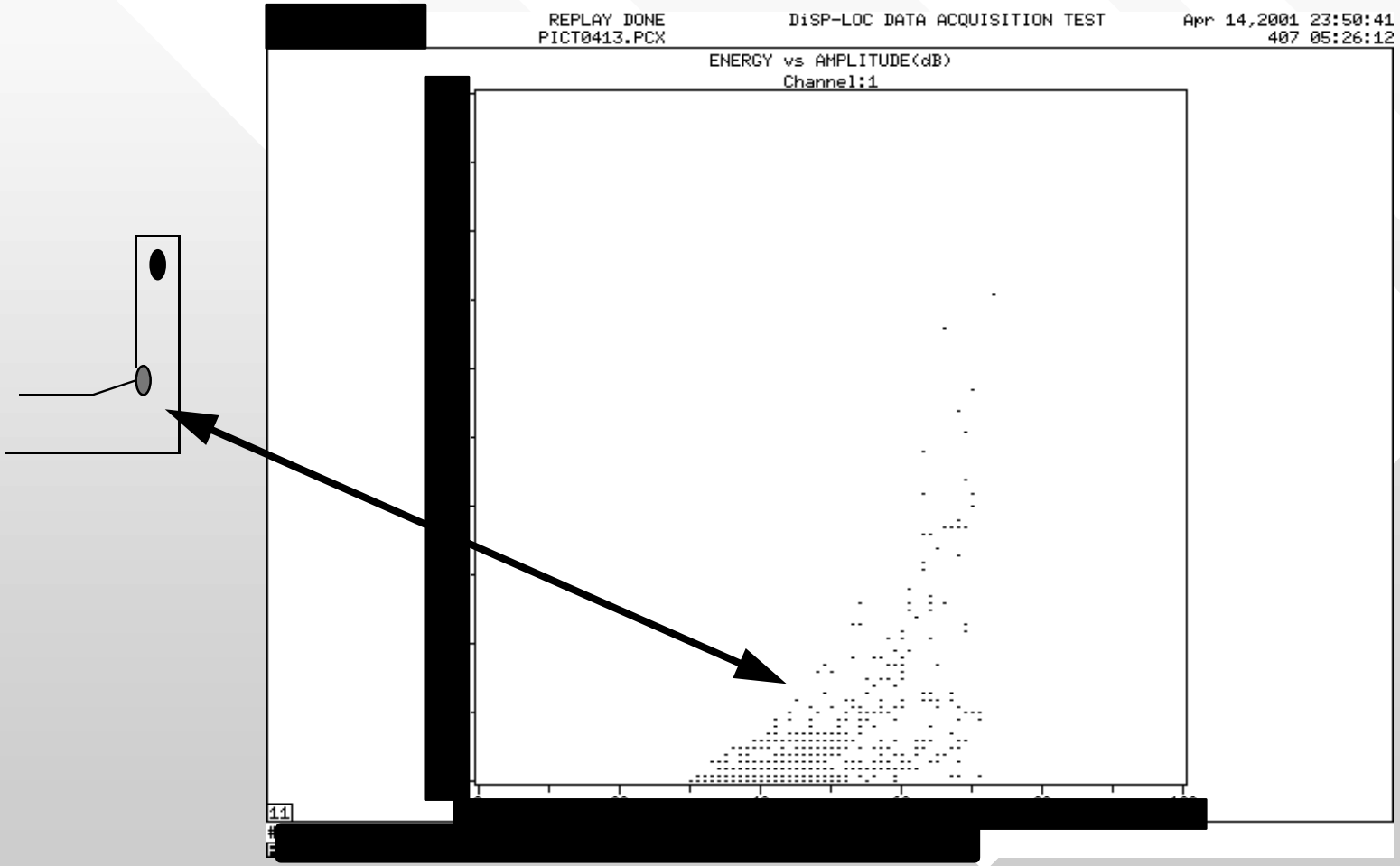


AE Data From Other Paper Machine Components

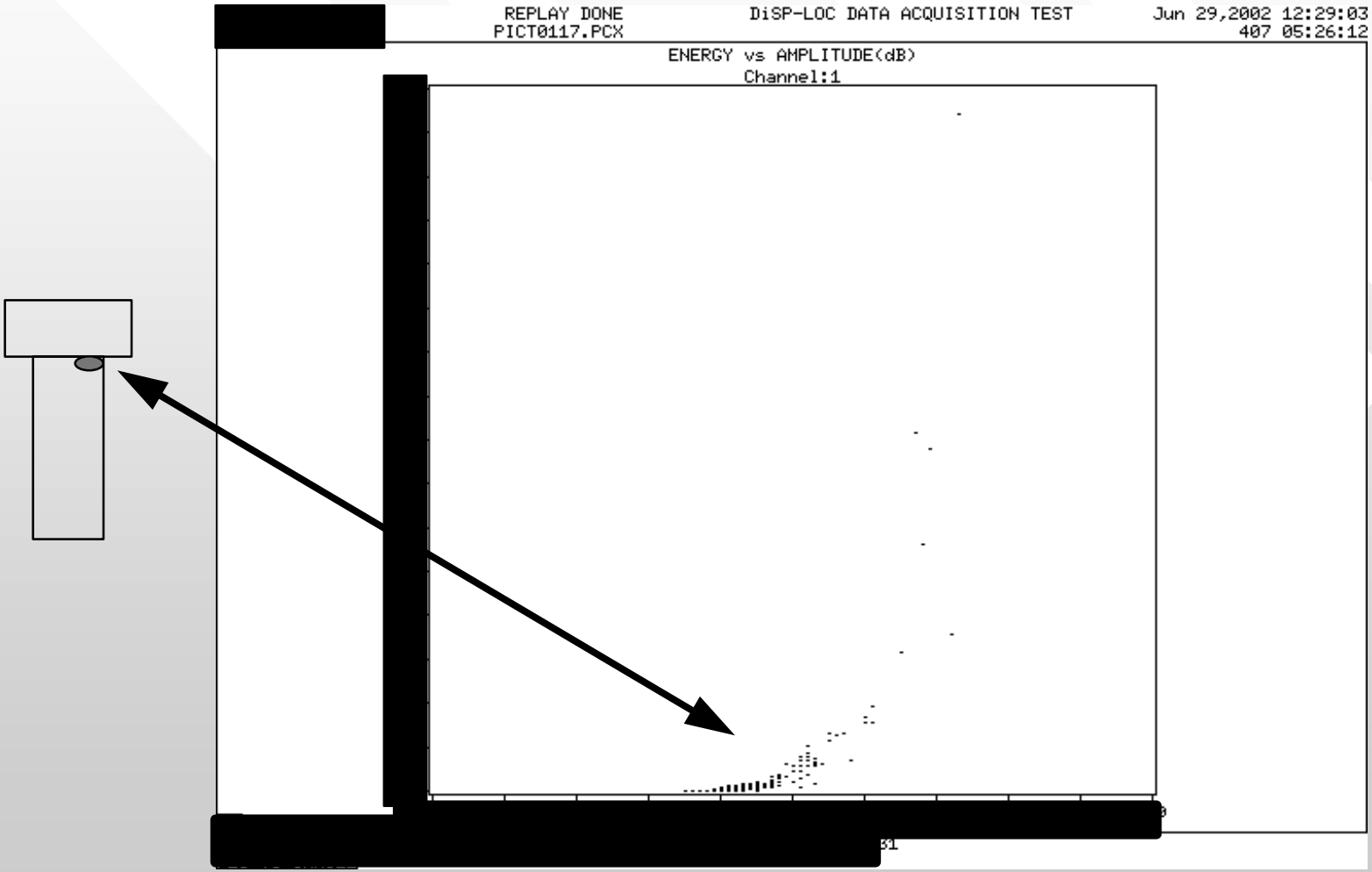
- Paper Machine Dryers
  - Suction roll shells
  - Suction roll cover delamination
  - Swing Arms
  - Felt rolls & reel spools
- Pressure vessels such as flash tanks

Fiberglass tanks
Storage tanks
Leak detection

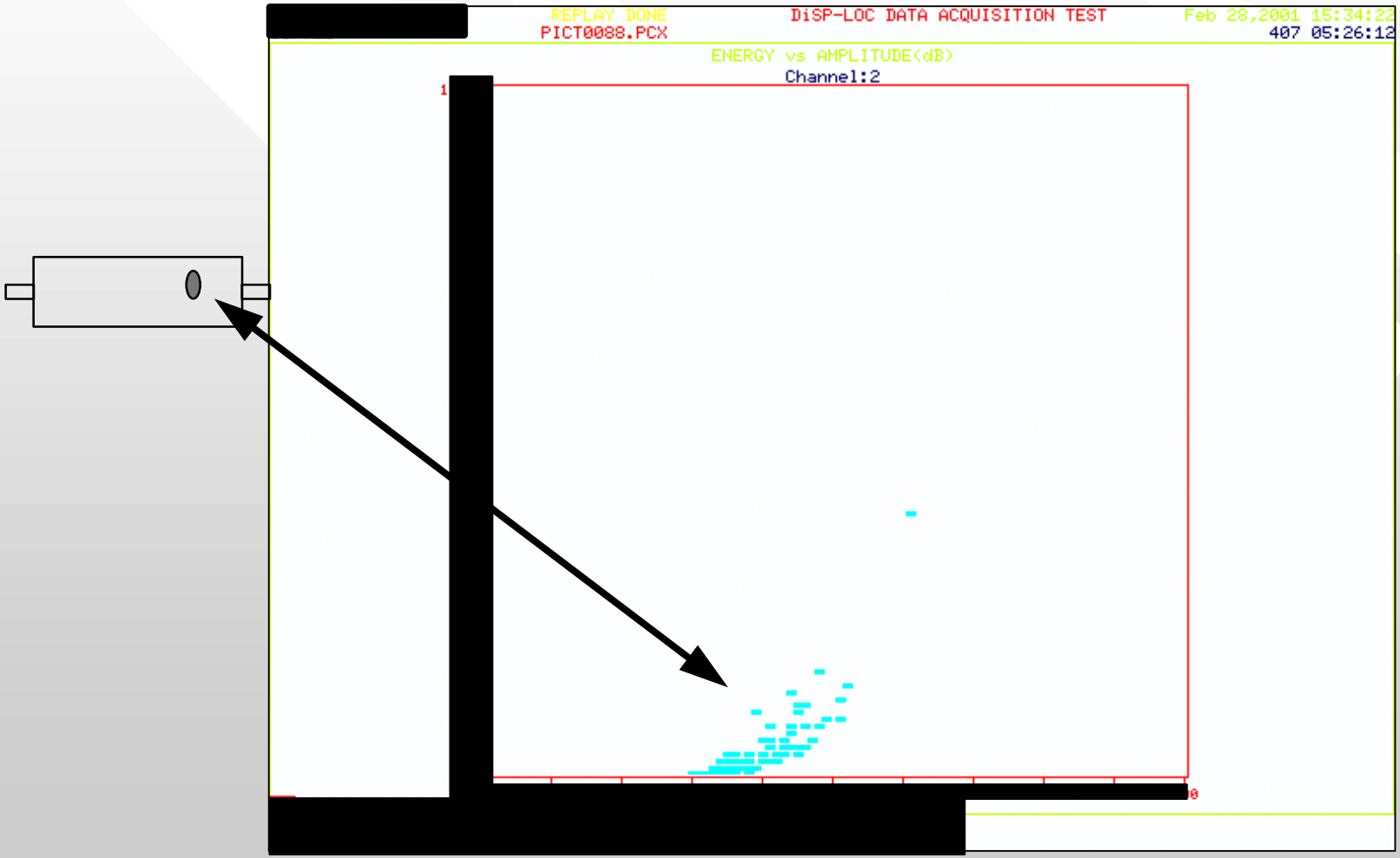
~4” Swing Arm Crack



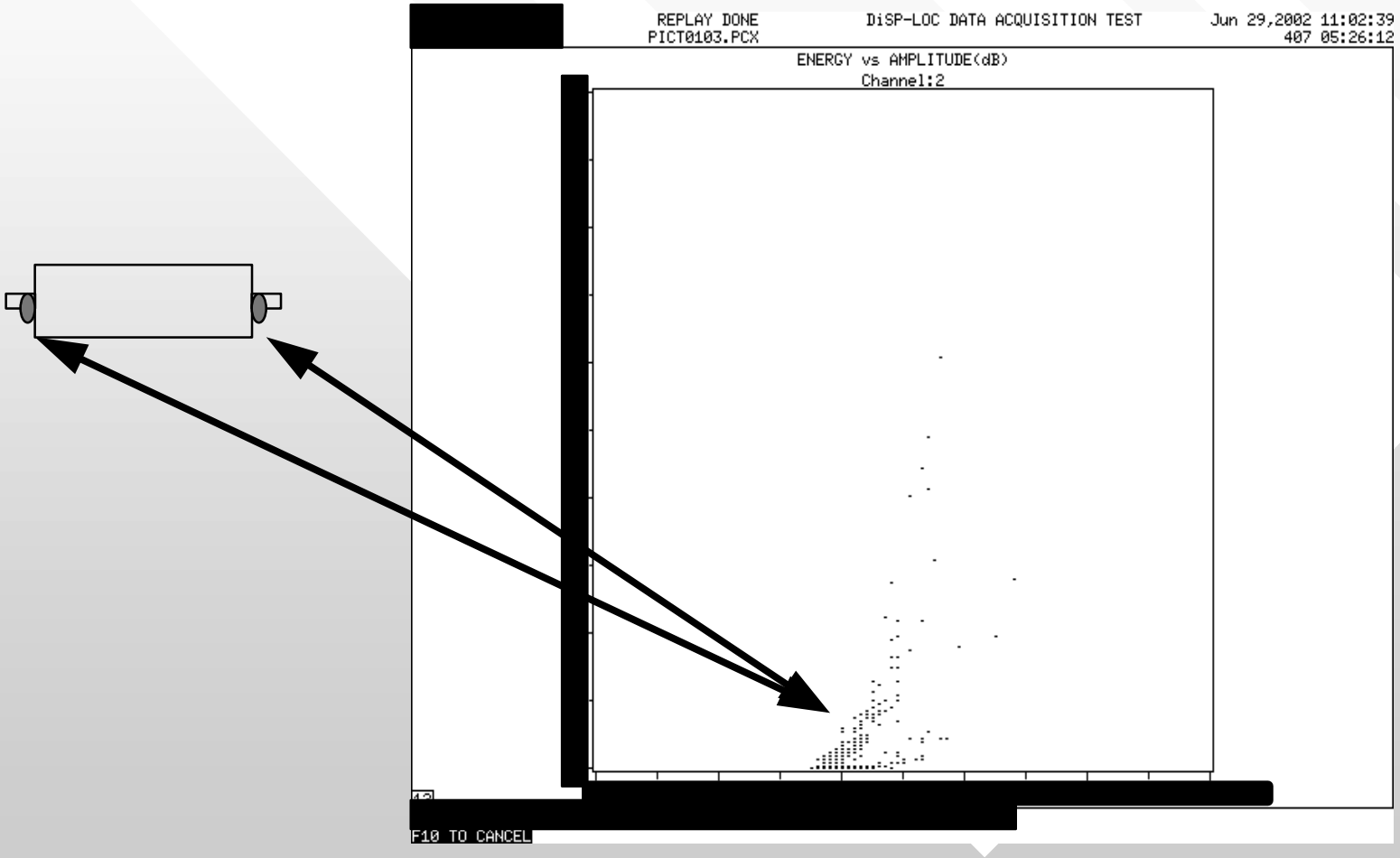
Cracked Head Bolt



Suction Roll: small cracks initially undetected with other NDE methods



Felt Roll: Journal Cracks



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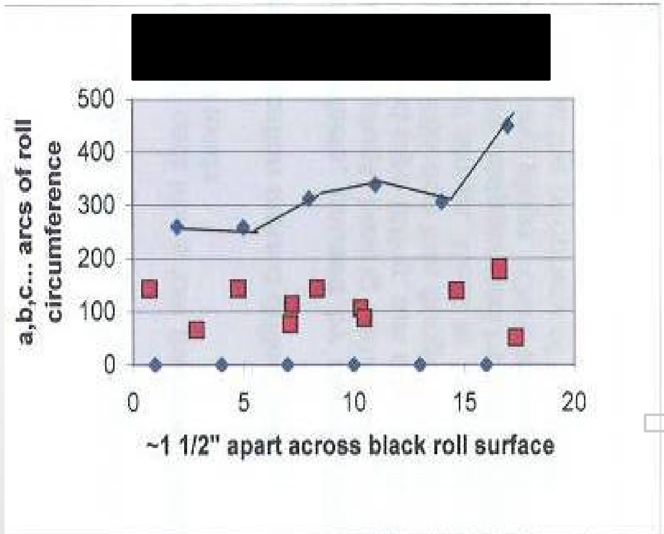
[redacted]



Signal dissipation over distance

Signal values related to anomalous sites

###	H	31	34	50		31		34		33	36		39	37		43
		31	33	32		33	31	30	34	35	38		39	38		46
		31	31	33		35	90	33		36	37	100	42	42		42
###	G	35		34	32	30	140	33		95-	39	128	40	37		41
		33		30	31	31	114	31		137	40	119	41	38		40
		34		34	35	33	122	33		37	35	132	40	36		42
###	F	34		31	30	33	D2	33	E	34	34	D1	33	37		41
		31	31	31		33		36		36	34		37	42		43
		30	30	36		33		37		35	36		36	43		40
###	E	34		35		38		37		35	35		38	40		43
		36		39		32		34		37	36		38	40	G	47
		37		34	33	30	35	35		37	37		40	41		49
###	D	34		33		35		35		38	40		38	141	48	48
		33		32	34	31	30	33		35	38		39	198	49	46
		33		33		35	34	31	35	34	36		39	37	46	45
###	C	35		37		35		34		39	37		37	42	37	43

A	Filed off bo
B	*Aluminum
C	Dirt placed
D	**Cuts in B
E	Thumb prir
F	Tape place
G	112 Lubrica
H	McLube ge

Thank You

Yankee Dryer Shell Crack

William G. Corboy, Jr. P.E.

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Why Study Failures?
Learning in a Particular Case

- Caveat Emptor
- New Yankee **documentation** is essential
- Independent New Yankee **inspection** is essential
- High velocity steam cuts thru steel like a hot knife through warm butter
- With good inspection and monitoring (and the right circumstances), it may be possible to successfully manage a failed Yankee through some interim period of operation

Dryer Particulars

- Installed in the UK
  - Built in 1992
  - Started-up in 1995
- Class 45 shell material
- 142.5” OD x 122” Face
- 8 BarG (116 Psig) Design Pressure
- Ribbed bore; 4 headers
- Cap-screwed and gasketed head/shell joint
- Short shell flange taper region
- Minimal clamping force at head/shell joint
- Sharp shell flange OD corner

Short History

- Steam leaks began shortly after startup
  - Initial sealant attempts began in Feb.1997
    - Pumping ports installed and sealant pumped
  - Sept 1997
    - Gasket missing in some locations
    - Dovetail groove and copper ring inserted
    - Pumping bolts and more pumping ports
    - ½” Plug noted near B/S shell ≈2mm from edge
  - March 1999 all bolts replaced with pumping bolts
  - Sept 1999 copper ring replaced

Short History (cont)

- Sheet edge cracks and slack edges
  - Sheet edge 4.4” from shell edge
  - Heavy water application to shell edges
- Sheet picking
  - Axial band of pitting 180^{O} from F/S manhole
  - Required polishing grinds on 3 month cycles
- Drying limited at 5085 fpm *vs.* 5906 fpm Design Speed
- Mill advised by Yankee service company in 1999 and 2000 to prepare to replace Yankee

Short History (getting longer)

- Dec. 2001 Inspection
  - Internal surfaces heavily oxidized and coated
  - Gap at spigot fit
  - Steam cut bolts and 19 with indications
  - Relevant AE data from B/S shell area
  - Excessive steam leaks on B/S make head tilt measurements impossible
  - High Percentage of Primary Carbides
  - Poorly formed graphite

Short History (longer still)

- Sealant applied to spigot fit April, May, Aug. 2002
- April & Aug. 2002 UT bolt inspections find bolt cracking and failure
- Jan 2003 Inspection
  - Uncovered unknown head flange repair
  - Steam cut bolts and 56 with indications
  - Shell runout greatest at B/S edge; Runout greatest at highest tilt location
  - Number of AE events > 50dB increased 5X in 13 months
  - MT uncovers cracking between shell plug and wall and exiting plug, ≈3/4” deep; plugs removed, crack ground
  - Reduced MAWP from 8 BarG to 2.5 BarG
  - Ordered new Yankee; Installed June 2003

Case History Summary

- Numerous Y/D design deficiencies
- Worst steam leakage ever encountered
- Yankee inspection tools – head tilt, runout, bolt UT, AE - are effective in locating failures and safely monitoring a deteriorating structural integrity


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