



NBIC

Inspection Tools for Historical Boilers

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Chief Boiler Inspector
Minnesota

History

- **“Those who fail to learn from history are condemned to repeat it.”**
- Winston Churchill, 1948 speech to the House of Commons



Historical Boilers

- Historical boilers are boilers that are being preserved, restored and maintained for demonstration, viewing or educational purposes.

How it all started...

- The Aeolipile (ee-ol-uh-pahyl)
- Created by Hero of Alexandria
- 10-70 AD



Introduction of the steam traction engine

- The self-propelled steam engine became popular in industrialized countries around 1850 and lasted until about 1930.
- Uses included threshing grain, plowing, mining, construction, sawmill operation, and the “hot pond”.



Increased Production

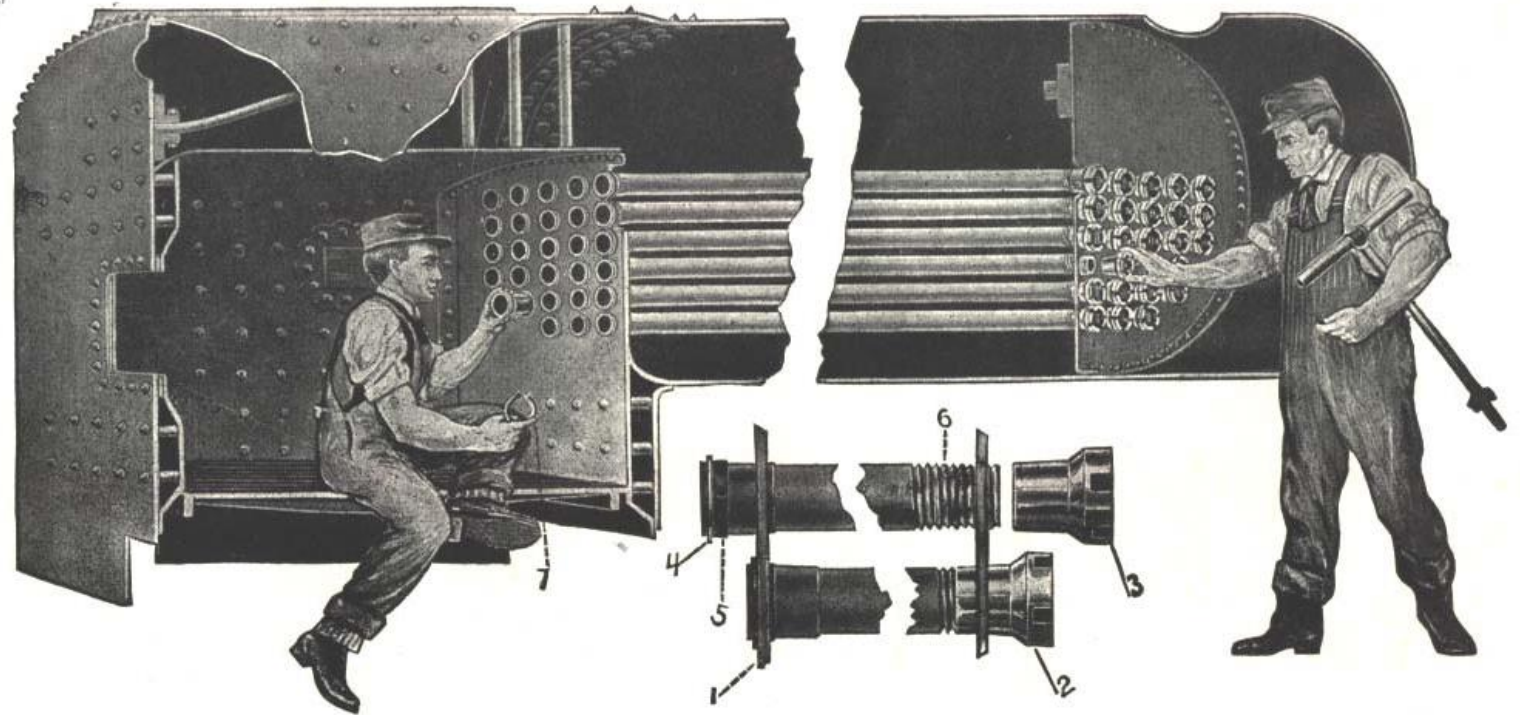
- Not only did the steam engine allow greater production for farming and lumber, the number of steam traction engines produced grew in great numbers.
- 91 Manufacturers of steam traction engines just in the United States between 1850 and 1930

This cut illustrates a section of the Patent Detachable Boiler Flue Device, and the method of inserting the same in a fire box boiler.

These Flues have given excellent satisfaction to users everywhere, and by reason of the ease with which they can be removed, cleaned and replaced, are especially desirable in those localities where operators are compelled to use bad and dirty water.

Boilers equipped with Detachable Flues will be charged with an extra price. Quotations made upon application.

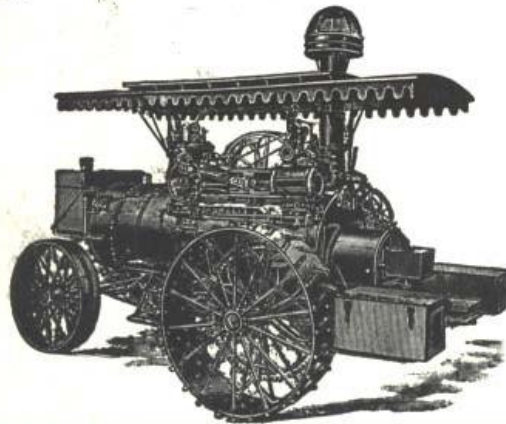
Address all Communications to
THE MINNEAPOLIS THRESHING
MACHINE CO.
West Minneapolis, Hopkins P.O. Minn.



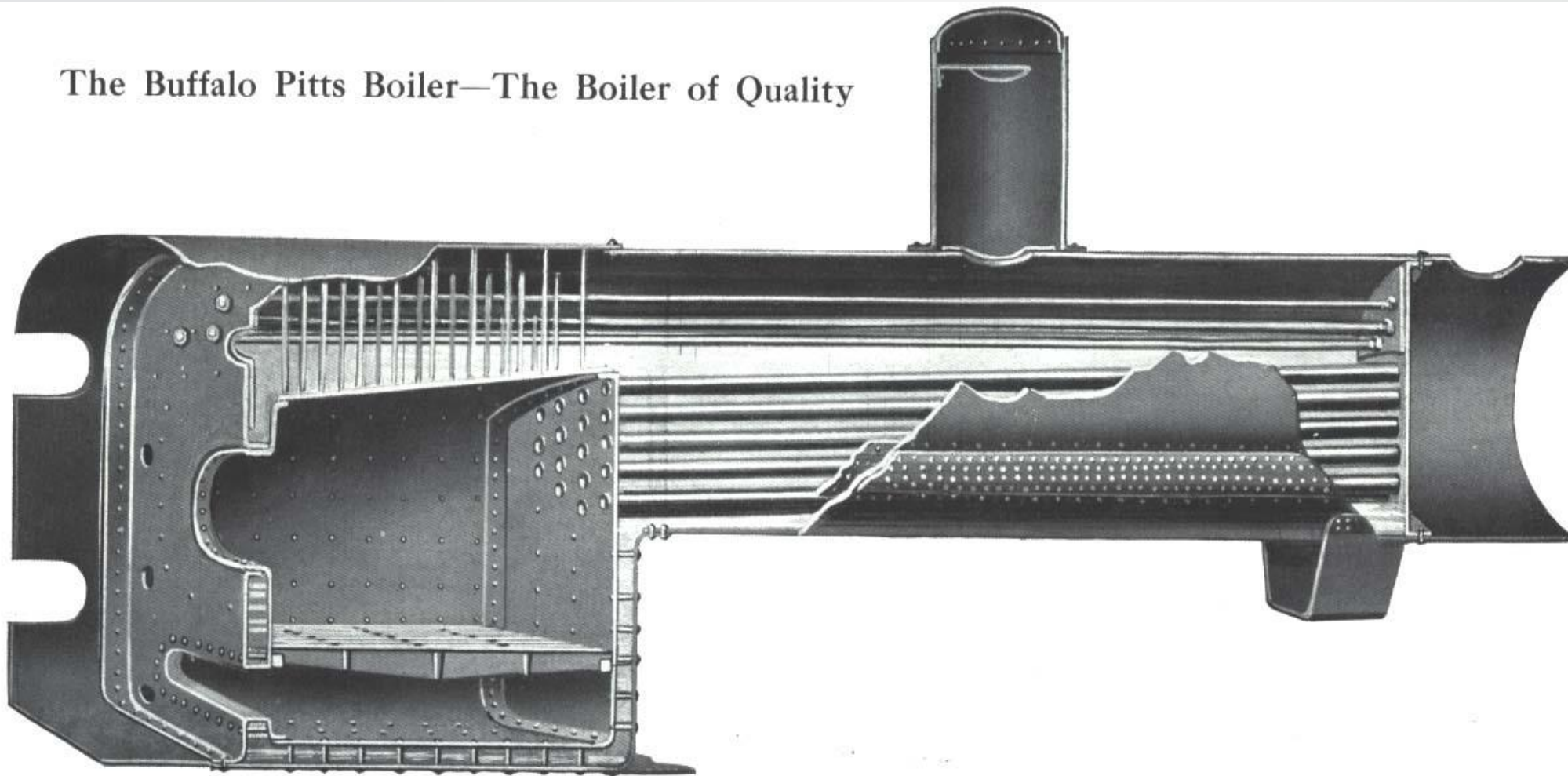
ANNOUNCEMENT

"The Great Minneapolis Line" has taken over and removed to its works at West Minneapolis, Minn., the entire plant, machinery, tools and stock of the Detachable Boiler Flue Manufacturing Co., of Minneapolis, Minn., and will manufacture Detachable Boiler Flues under its patents for **all makes, sizes and styles** of boilers.

Circulars describing this Patent Detachable Flue will be sent free on application.



The Buffalo Pitts Boiler—The Boiler of Quality





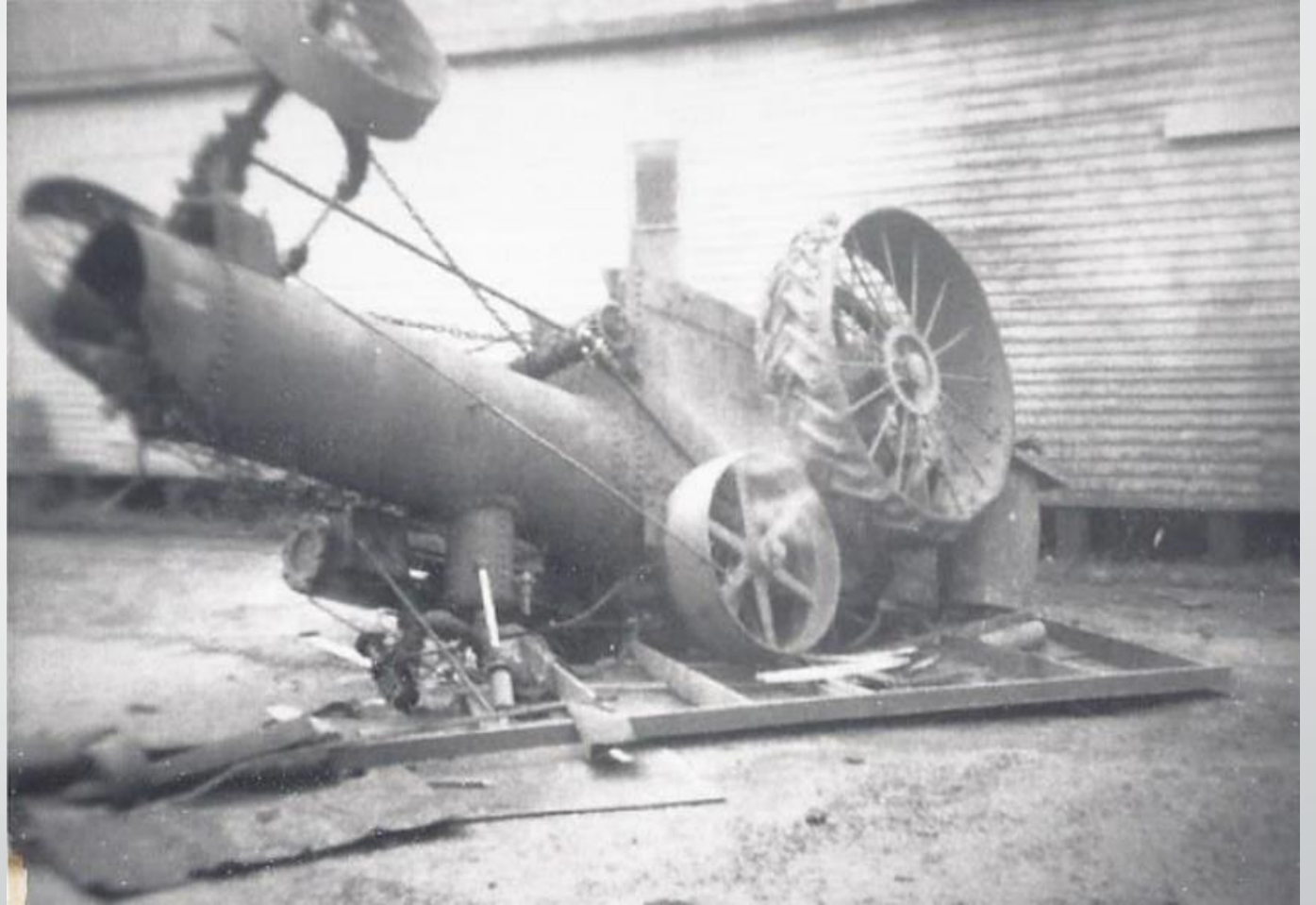
*30 h.p. Gaar-Scott Engine owned
by T. Takeda, Erin, Texas break-
ing 600 acres of black hog-
wallow land for rice.*

History

- Prior to 1913 there were no construction standards in the U.S.
- Very few inspection programs prior to 1881
- No water treatment programs
- Operator Training was limited, very few licensed operators

Incidents and Accidents

- Between 1850 and 1930 there were many explosions that resulted in loss of life
- Many of these were due to improper repairs and untrained operators




Today

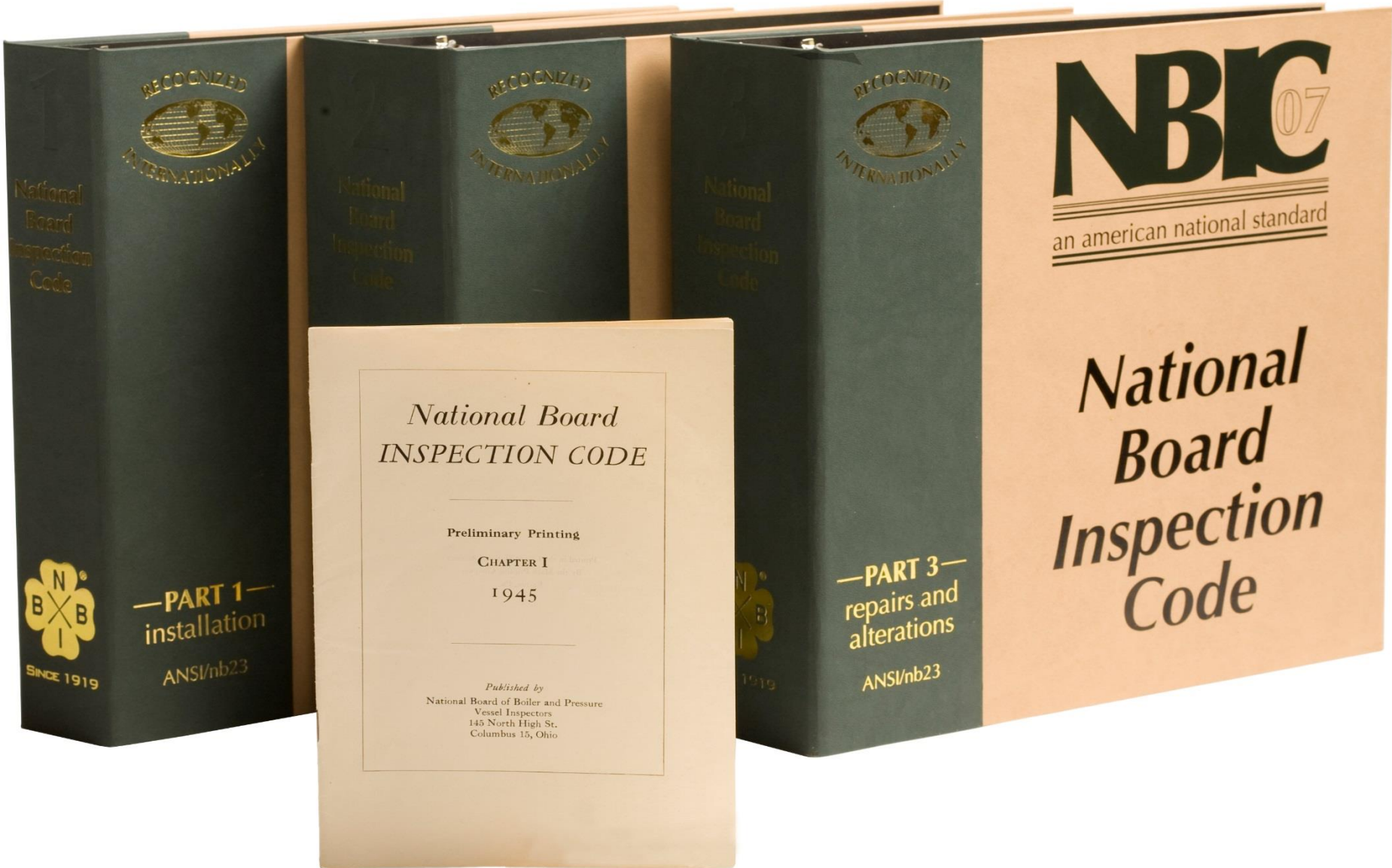
- Many of these historical boilers still exist as a reminder of our history
- Minnesota has approximately 160 operating historical boilers







So, How do you keep a 100 year old
boiler operating safely?



RECOGNIZED
INTERNATIONALLY

National Board
Inspection Code



—PART 1—
installation
ANSI/nb23

RECOGNIZED
INTERNATIONALLY

National Board
Inspection Code

National Board
INSPECTION CODE

Preliminary Printing

CHAPTER I

1945

Published by
National Board of Boiler and Pressure
Vessel Inspectors
145 North High St.
Columbus 15, Ohio

RECOGNIZED
INTERNATIONALLY

National Board
Inspection Code




—PART 3—
repairs and
alterations
ANSI/nb23

NBIC 07
an american national standard

**National
Board
Inspection
Code**

National Board Inspection Code (NBIC)

- First Published in 1945 it was 27 pages.
- Provided guidance and rules for the inservice repair and alteration of boilers
- 2017, now in 4 parts, Installation, Inspection, Repairs and Alterations, and Pressure relief devices, now over 800 pages.
- Public Safety, Maintain pressure retaining items by providing rules for the installation, inspection and repair, thereby ensuring that these items may continue to operate safely



**RECOMMENDED
RULES FOR REPAIRS
BY FUSION WELDING
TO POWER BOILERS**

AND

**UNFIRED PRESSURE
VESSELS**

(over 15 lb. pressure)

TABLE OF CONTENTS

No Repairs by Welding Without Inspector's Approval	4
Rules for Welding	5
Cracks—Permissible Welded Repairs	7
Building Up of Corroded Surfaces	9
Seal Welding	10
Re-ending and Piecing Tubes	11
Patches, Unstayed Sheets	12
Patches, Stayed Sheets	13
Patches, Tube Sheets, Fire Tube Boilers	15
Repair of Tube Holes	16



Today

2015 NBIC Part 2, Inspection

- General and Detailed requirements for the inspection of Pressure Retaining items
 - Historical Boilers

NBIC Subgroup Historical

Name	Interest Category	Role
Joel Amato	Jurisdictional Authorities	Chair
Tom Dillon	Owners and Operators General Interest	Vice Chair
Jim Getter	Manufacturers	Member
Frank Johnson	Users	Member
David Rose	Owners and Operators General Interest	Member

NBIC Subgroup Historical

Name	Interest Category	Role
Dennis Rupert	Owners and Operators General Interest	Member
Robert Underwood	Authorized Inspection Agencies	Member
Mike Wahl	Owners and Operators General Interest	Member

NBIC Historical Subgroup

- Meets twice per year
- Reports to:
 - Part 2, Inspection
 - Part 3, Repairs and Alterations

NBIC Part 2, Supplement 2

Historical Boiler

- Inspection Requirements
 - Inspectors
 - Owners
 - Operators

Supplement 2, Historical Boiler Inspections

- Provides Inspector guidance and requirements on inspection and examination methods
- Examination Methods
 - Visual
 - Ultrasonic
 - Liquid Penetrant
 - Magnetic Particle
 - Radiographic
 - Hydrostatic test
 - Inservice inspection



Supplement 2, Historical Boiler Inspections

- Required Examinations
 - Ultrasonic
 - Visual
 - Inservice Inspection
 - Hydrostatic



Supplement 2, Historical Boiler Inspections

- Initial inspection requires all required examination types
 - Ultrasonic
 - Visual examination
 - Hydrostatic test
 - Inservice Inspection
- Establish Maximum Allowable Working Pressure (MAWP) for each component

Subsequent Inspections

- Following year after initial inspection
 - First year: Inservice Inspection
 - Second year: Visual Inspection
 - Third year: Hydrostatic pressure test
 - Fourth year: Inservice Inspection
 - Fifth year: Ultrasonic thickness testing
 - Sixth year: Hydrostatic pressure test
 - Seventh year: back to first year

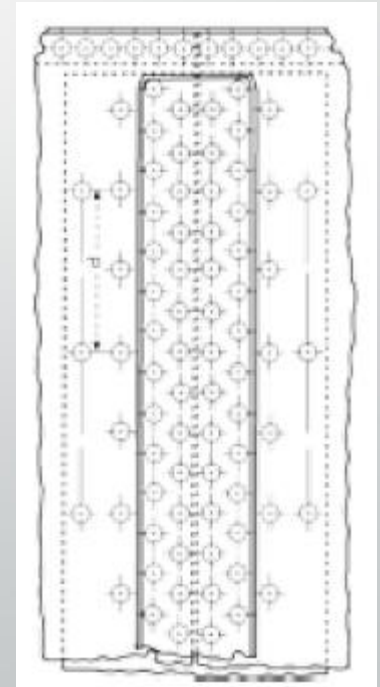
Supplement 2, Historical Boiler Inspections (Ultrasonic)

- Inspectors no longer perform calculations for cylindrical components (barrels)
- $$P = \frac{TS \times t \times E}{R \times FS}$$
- This helps prevent errors
- Allows owner/operator to double check results

Supplement 2, Historical Boiler Inspections (Ultrasonic)

- Based on the joint type, Shell ID, and Shell Thickness they can use a chart to determine the MAWP

Shell ID	Minimum Thickness of Shell Plate																		
	0.19	0.2	0.21	0.22	0.23	0.24	0.25	0.26	0.27	0.28	0.29	0.3	0.31	0.32	0.33	0.34	0.35	0.36	0.37
12	327	345	362	379	396	414	431	448	465	483	500	517	534	551	569	586	603	620	638
13	302	318	334	350	366	382	398	414	430	445	461	477	493	509	525	541	557	573	589
14	281	295	310	325	340	355	369	384	399	414	428	443	458	473	487	502	517	532	547
15	262	276	290	303	317	331	345	358	372	386	400	414	427	441	455	469	483	496	510
16	246	259	271	284	297	310	323	336	349	362	375	388	401	414	427	439	452	465	478
17	231	243	255	268	280	292	304	316	328	341	353	365	377	389	401	414	426	438	450
18	218	230	241	253	264	276	287	299	310	322	333	345	356	368	379	391	402	414	425
19	207	218	229	239	250	261	272	283	294	305	316	327	337	348	359	370	381	392	403
20	196	207	217	227	238	248	259	269	279	290	300	310	321	331	341	352	362	372	383
21	187	197	207	217	226	236	246	256	266	276	286	295	305	315	325	335	345	355	364
22	179	188	197	207	216	226	235	244	254	263	273	282	291	301	310	320	329	338	348
23	171	180	189	198	207	216	225	234	243	252	261	270	279	288	297	306	315	324	333
24	164	172	181	190	198	207	215	224	233	241	250	259	267	276	284	293	302	310	319
25	157	165	174	182	190	199	207	215	223	232	240	248	256	265	273	281	290	298	306



Supplement 2, Historical Boiler Inspections (Ultrasonic)

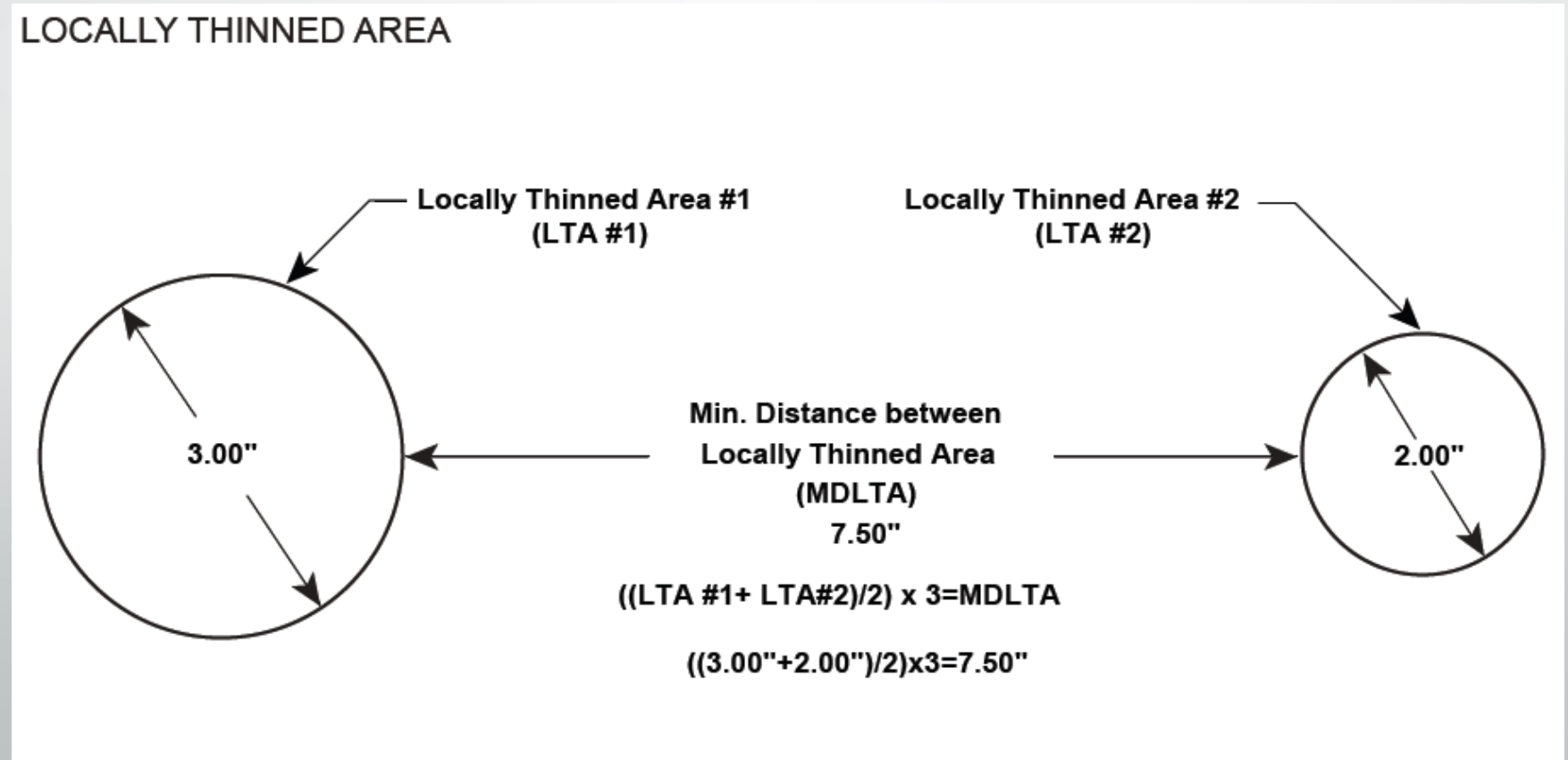
- Inspectors no longer perform calculations for areas with stayed surfaces (firebox, wrapper sheet)

$$P = \frac{t^2 \cdot S \cdot C}{p^2}$$

Thickness of Stayed Surface, in.	Staybolt Spacing (Maximum Pitch, in.)													
	3.5	3.625	3.75	3.875	4	4.125	4.25	4.375	4.5	4.625	4.75	4.875	5	5
0.19	85	80	74	70	65	61	58	55	52	49	46	44	42	
0.20	95	88	82	77	72	68	64	61	57	54	51	49	46+	
0.21	104	97	91	85	80	75	71	67	63	60	57	54	51	
0.22	115	107	100	93	88	82	78	73	69	66	62	59	56	
0.23	125	117	109	102	96	90	85	80	76	72	68	65	61	
0.24	136	127	119	111	104	98	92	87	82	78	74	70	67	
0.25	148	138	129	121	113	106	100	95	89	85	80	76	72	
0.26	160	149	139	130	122	115	108	102	97	92	87	82	78	
0.27	172	161	150	141	132	124	117	110	104	99	94	89	85	
0.28	185	173	162	151	142	134	126	119	112	106	101	96	91	
0.29	199	185	173	162	152	143	135	127	120	114	108	103	97	
0.30	213	198	185	174	163	153	144	136	129	122	116	110	104	
0.31	227	212	198	185	174	164	154	146	138	130	123	117	111	

Supplement 2, Historical Boiler Inspections (Ultrasonic)

- Also provides inspector guidance and requirements for locally thinned areas



Supplement 2, Historical Boiler Inspections (Hydrostatic Testing)

- Leak tightness testing
- Pressure for test shall be 1.25 times MAWP
- Held for 10 minutes or as long as it takes to perform a complete visual inspection
- Water temperature must be between 60 and 120 degrees F

Supplement 2, Historical Boiler Inspections (Visual Examination)

- Fusible plugs
- Openings or connections in the boiler
- Mechanical attachment points
- Boiler sheets
- Tubes

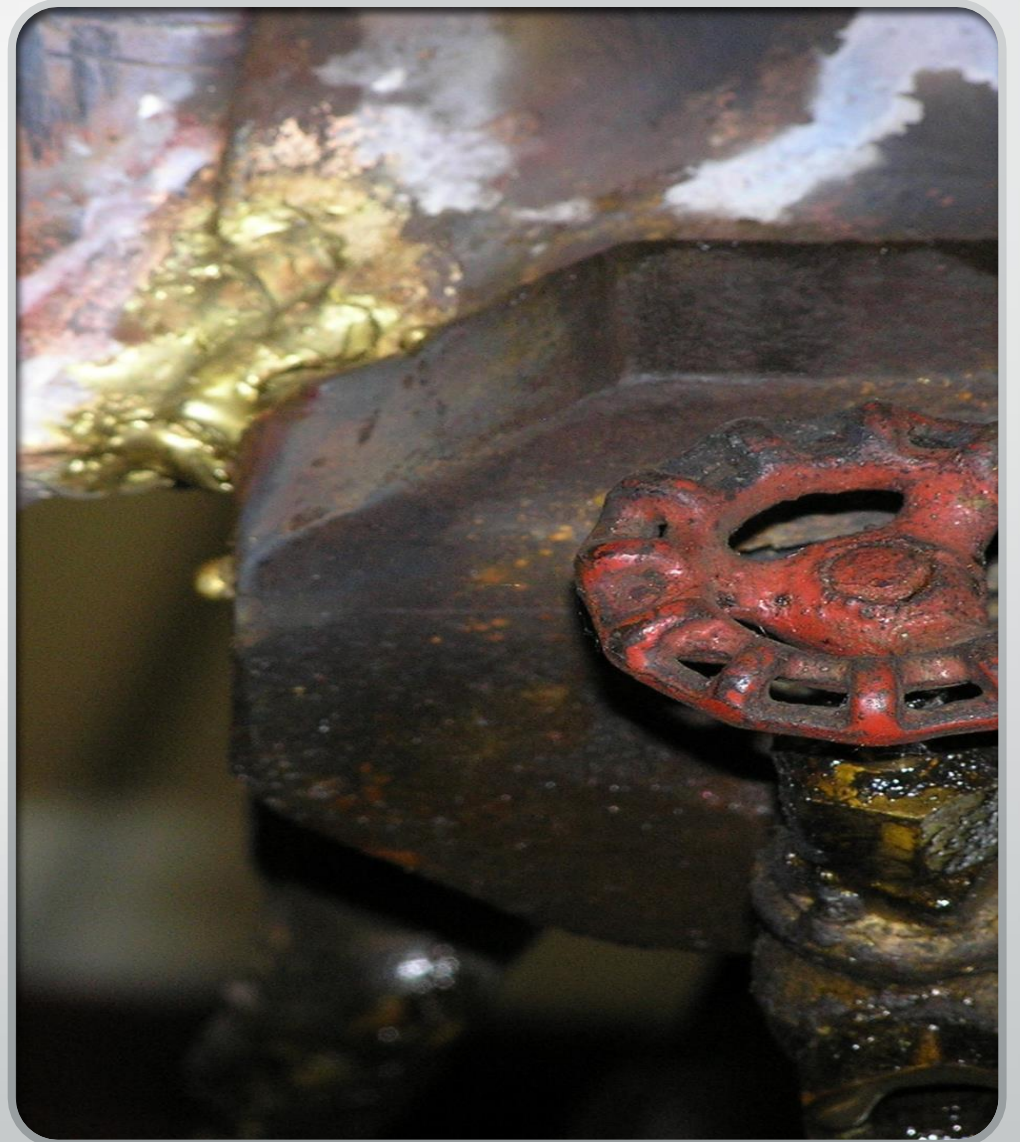
Supplement 2, Historical Boiler Inspections (Inservice Inspection)

- Demonstration of:
- Two means of boiler feedwater delivery
- Tri-cocks and correlation with gage glass level
- Gage glass upper and lower shutoff valves
- Gage glass blowdown
- Pressure gage
- Safety valve test, and verify stamping and set pressure



NBIC Part 3, Repairs and Alterations

- Part 3, Supplement 2, Specifically for repairs and alterations to Historical Boilers
- Repairs to stayed surfaces, riveted seams, unstayed surfaces, tubes, staybolts and all parts of historical boilers



NBIC

Part 3, Supplement 2

- Inspectors, Owners, and Operators
- All welded repairs must be performed by an National Board Certified "R" stamp company



Part 3, Supplement 2, Repairs

- Provides detailed diagrams and illustrations for examples of repair methods.

SEAL WELDING STAYBOLTS

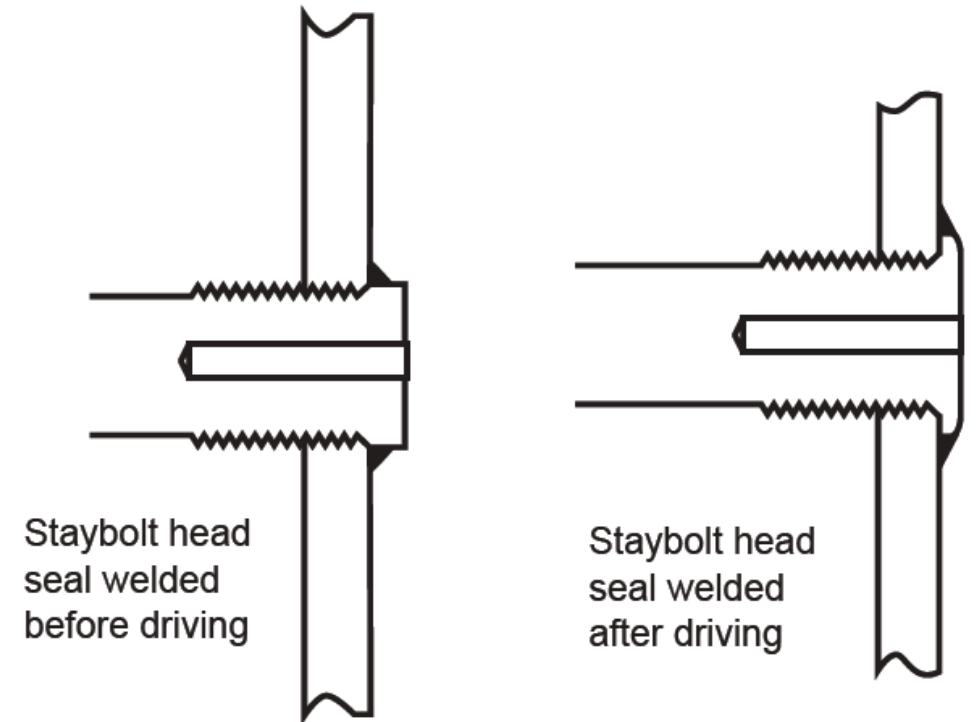
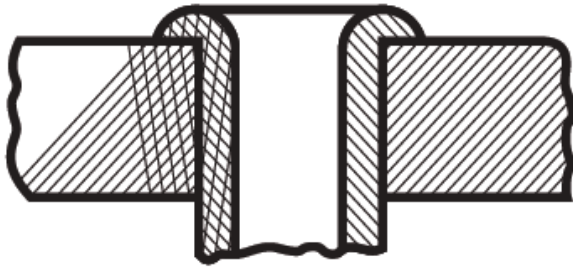
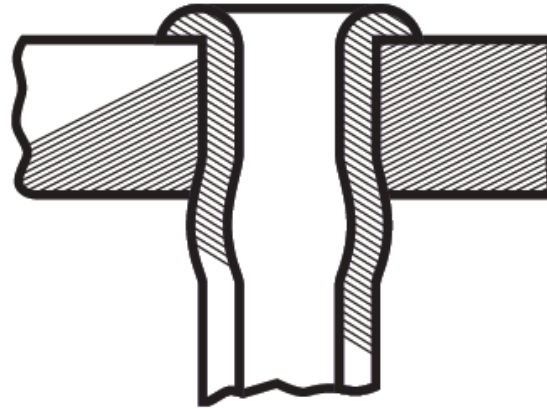


FIGURE S2.13.8

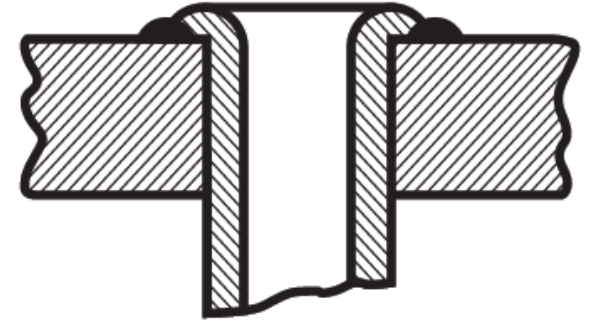
ACCEPTABLE FORMS OF TUBE ATTACHMENTS



(a)



(b)

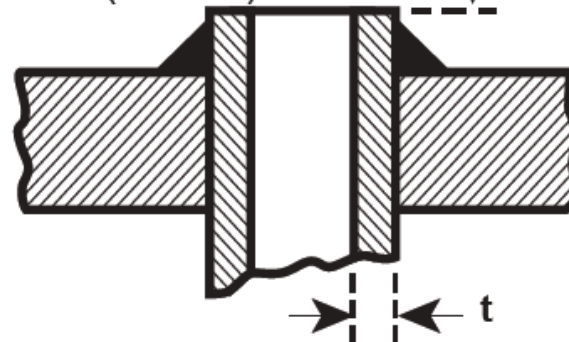


(c)

Not over $2t$ nor less than t but in
no case more than $1/4$ in. (6.3mm)
nor less than $1/8$ in. (3.2 mm)

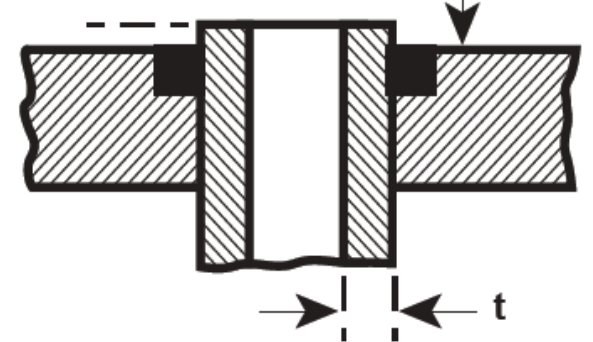


(d)



(e)

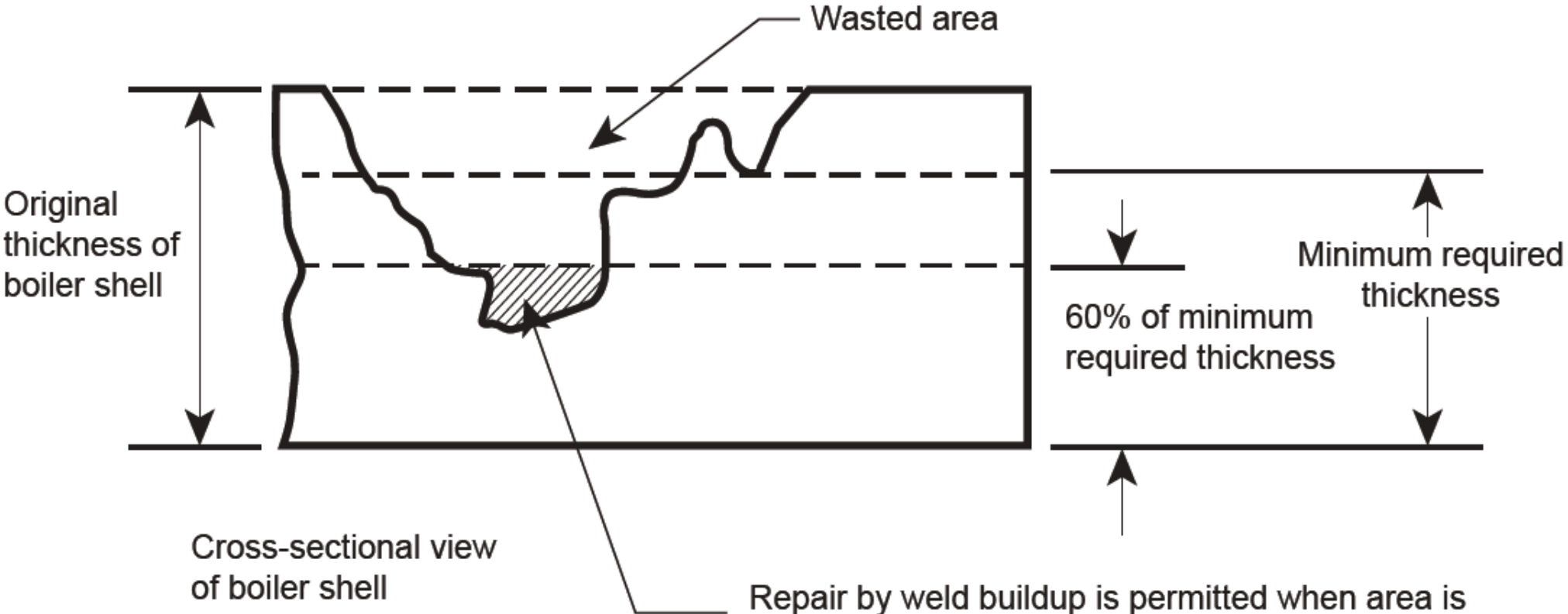
Not less than t and
in no case less than
 $1/8$ in. (3.2 mm)



(f)

FIGURE S2.13.9.1

WELD BUILDUP




Repair by weld buildup is permitted when area is not greater than 3 sq. in. (1950 sq. mm)

NBIC Note:

- It should be recognized that safety of these boilers is dependent upon the knowledge and training of the operator in proper use, repair, maintenance, and safe operation of each specific boiler.

University of Rollag Rollag, Minnesota

- Two day school for Historical Boiler Operators
- Annually on Father's Day Weekend
- 16 hours of credit toward your Minnesota Historical Boiler Engineers License
- Chief Inspectors may attend for free!
- Open to all
- There are also steam traction schools in Wisconsin, Iowa and Oklahoma

- 
- How many Chief Boiler Inspectors does it take to safely operate a Historical Boiler?

At least two...

