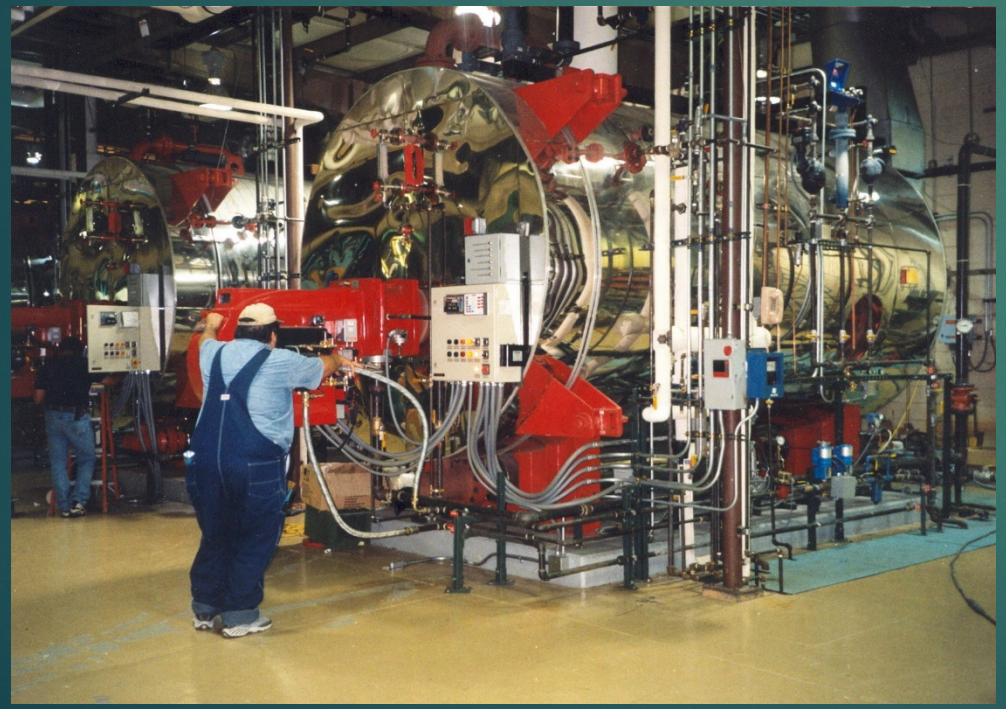
WARGA INDUSTRIES
ELIMINATE COMPROMISE

WARGA BOILER VS SCOTCH MARINE

CRASH COURSE



WARGA BOILER



SCOTCH MARINE BOILER

WARGA BOILER VS SCOTCH MARINE

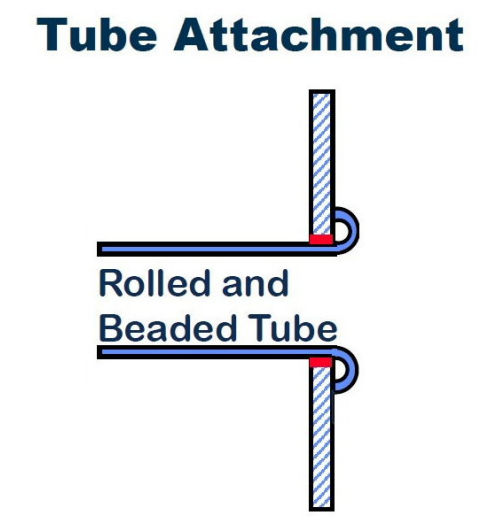
TABLE OF CONTENTS

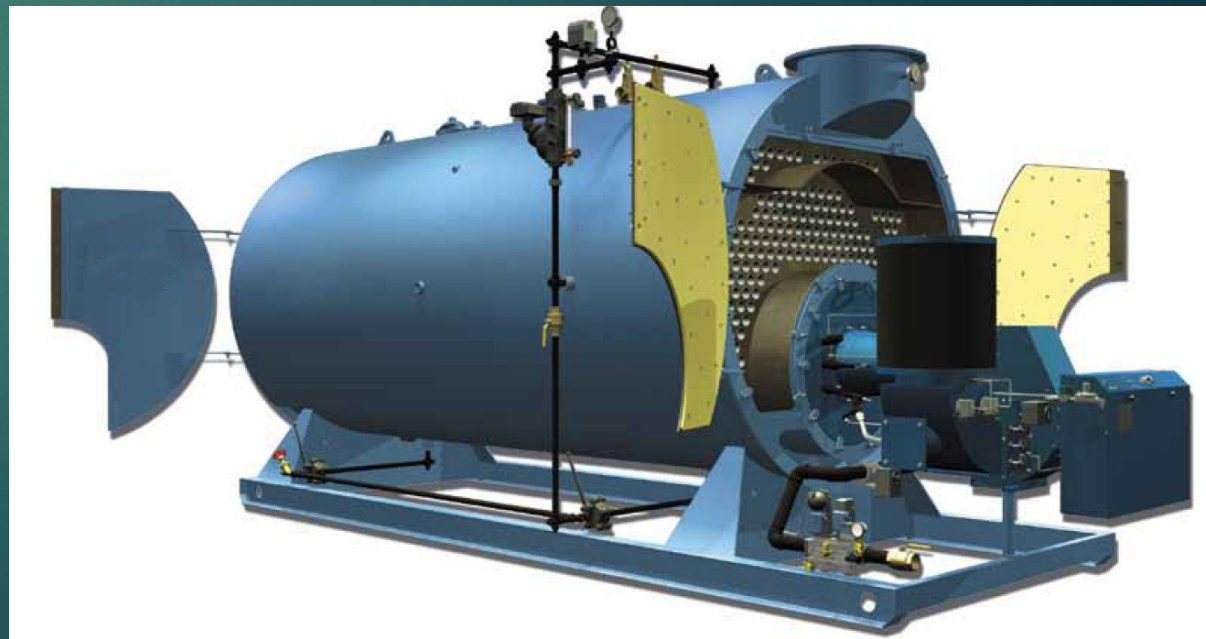
1. Scotch Marine boiler
2. Introducing Warga boiler
3. Warga boiler design vs Scotch Marine
4. Retrofit to Warga design

1. SCOTCH MARINE BOILER

SCOTCH MARINE BOILER

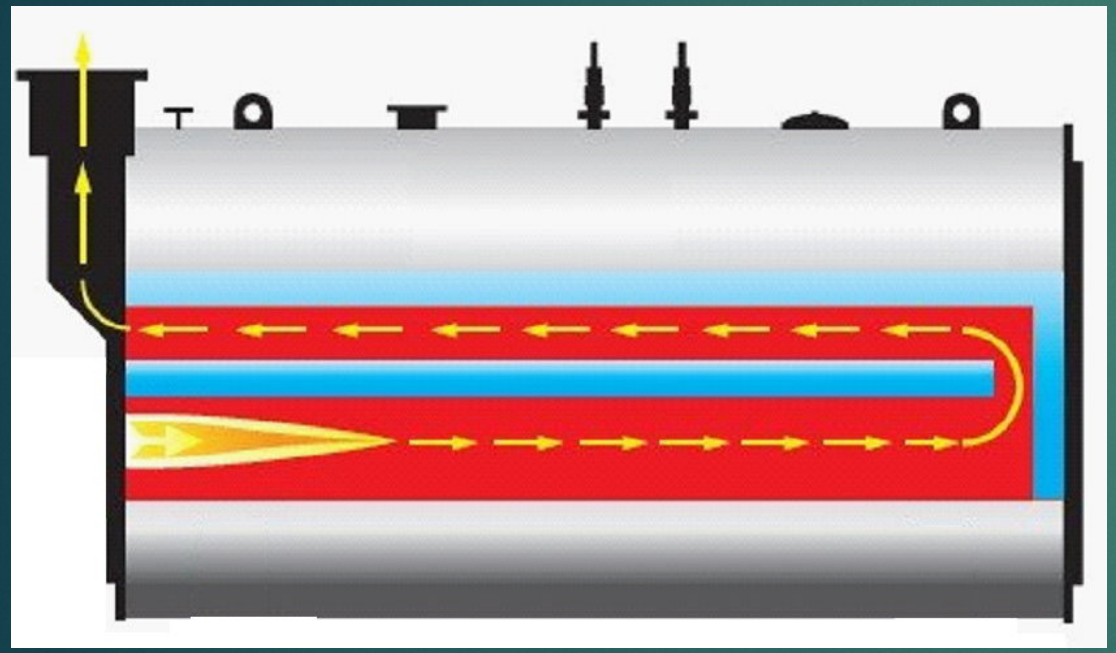
- Design rule: 5sq.ft./HP
- US industry standard for over 150 years
- US inventory size: 160.000+ units
- Models:
  - 2-pass, 3-pass, 4-pass
- Variants:
  - wetback, dryback
- Tube attachment
  - rolled & beaded

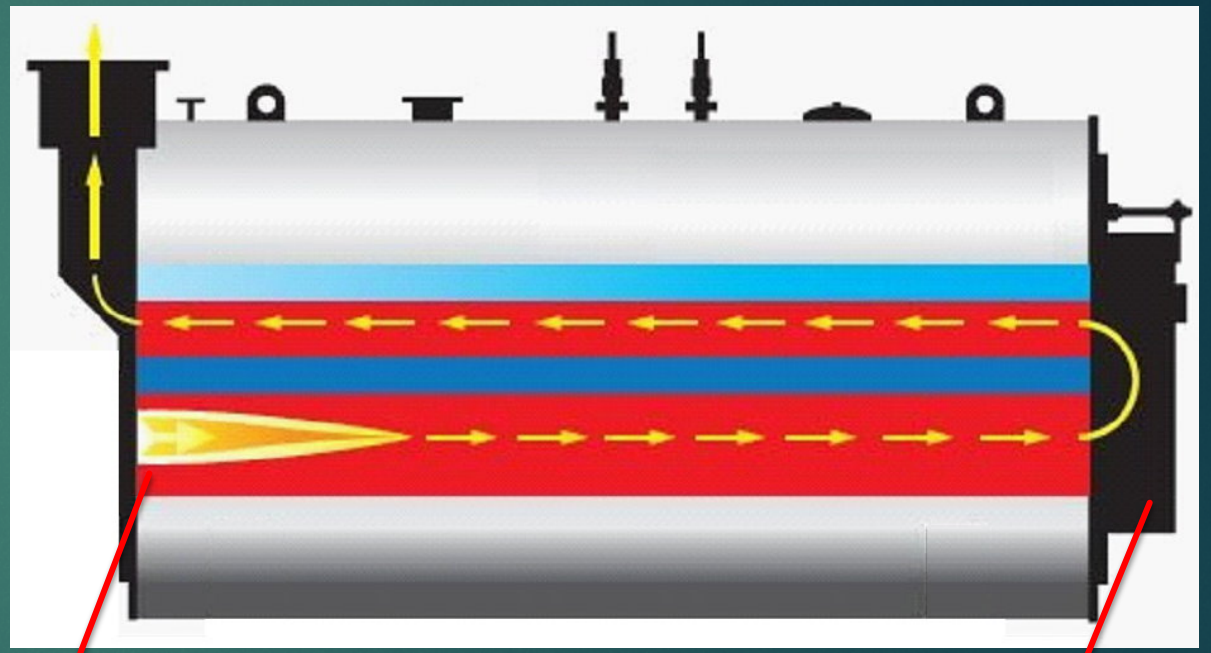




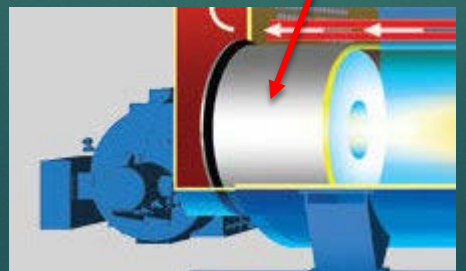
SCOTCH MARINE BOILER

2-PASS: ONE SET OF TUBES





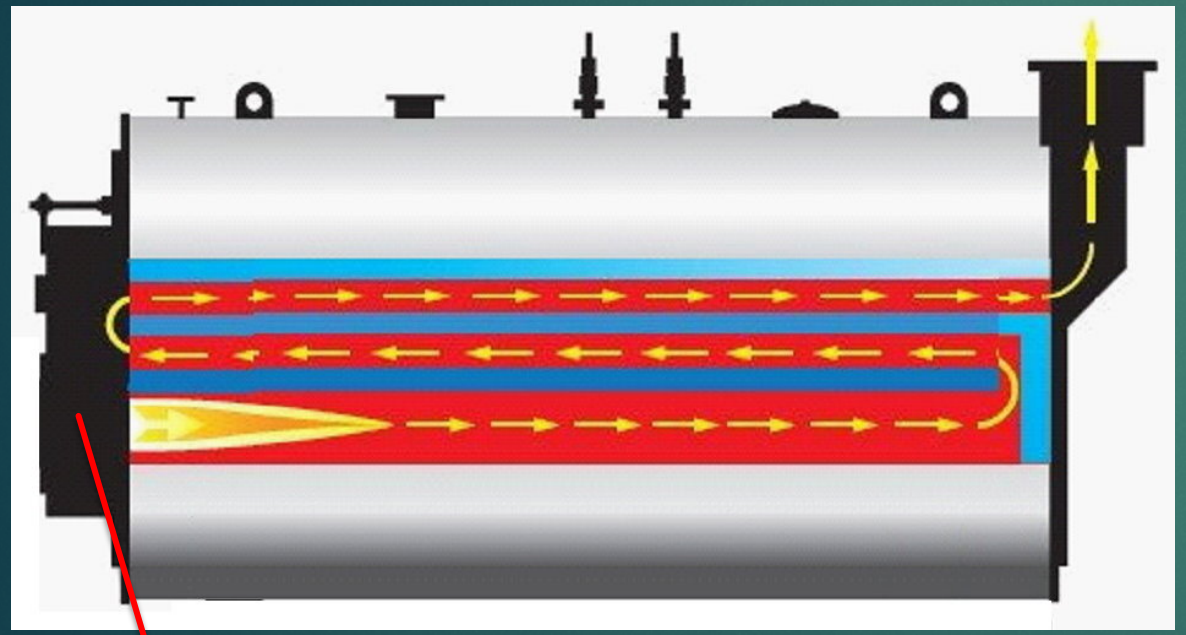
Wetback
Refractory ring around burner



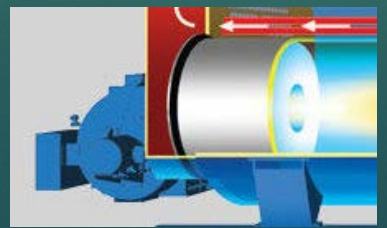
Dryback
Refractory ring around burner
Refractory-lined rear turnaround

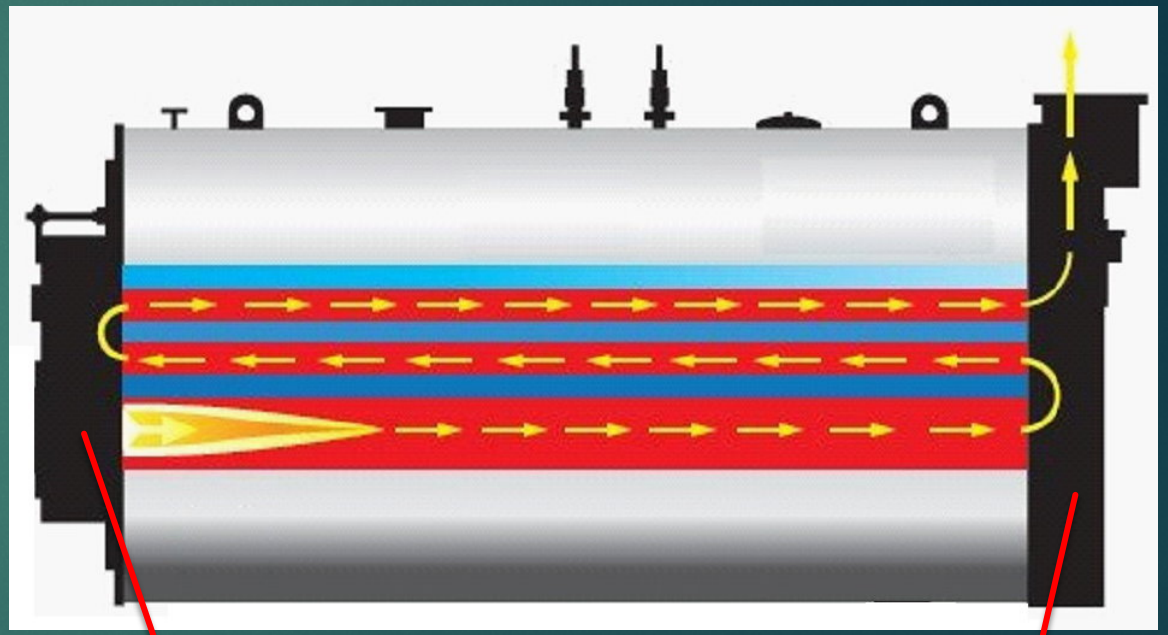
SCOTCH MARINE BOILER

3-PASS: TWO SETS OF TUBES



Wetback
Refractory ring around burner
Refractory-lined front turnaround

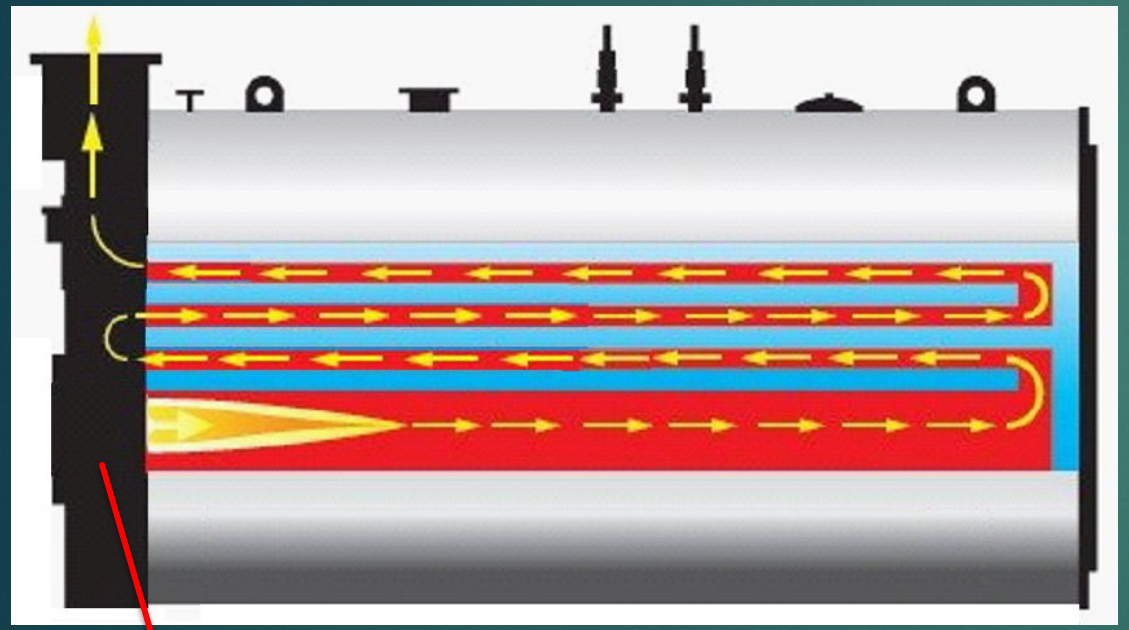




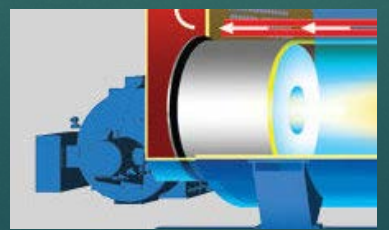
Dryback
Refractory ring around burner
Refractory-lined front turnaround
Refractory-lined rear turnaround

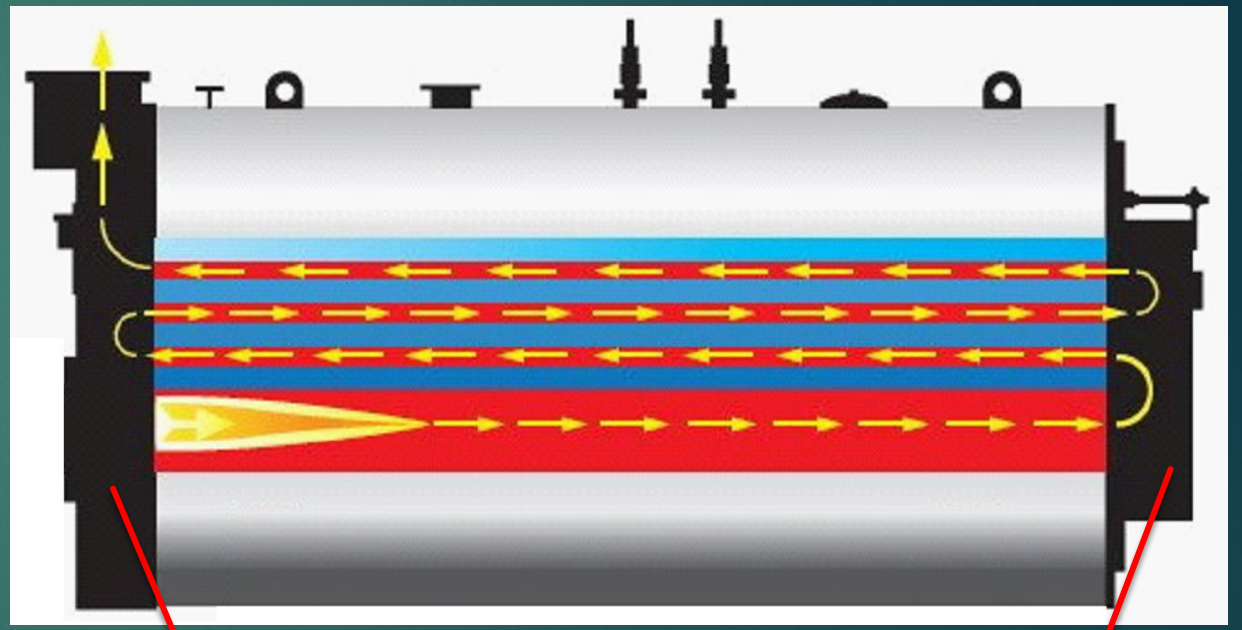
SCOTCH MARINE BOILER

4-PASS: THREE SETS OF TUBES



Wetback
Refractory ring around burner
Refractory-lined front turnaround





Dryback
Refractory ring around burner
Refractory-lined front turnaround
Refractory-lined rear turnaround

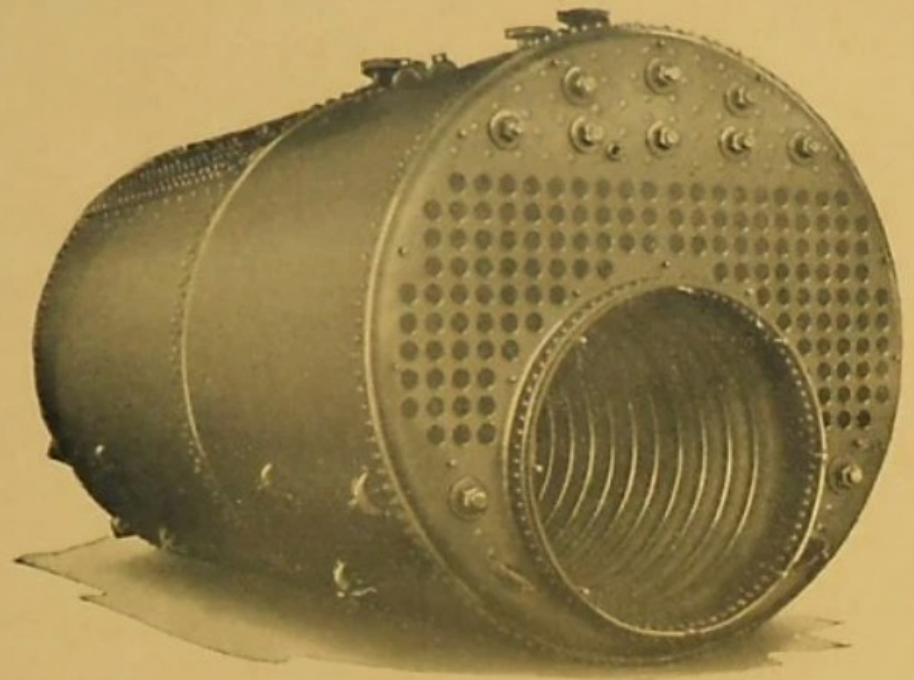
SCOTCH MARINE BOILER

DEFICIENCIES

- Lack of innovation
- Tubes not welded
- Inner welds to be inspected by crawling through manhole
- High exterior losses
- Lots of refractory, which traps heat, impacting efficiency
- Turndown impacts efficiency
- Excessive tube number reduces velocity, with poor heat transfer at turndown
- Repairs are common

SCOTCH MARINE BOILER – LACK OF INNOVATION

SCOTCH MARINE BOILER IN 1939



Custom-made when necessary to exactly meet your needs for capacity—fuel—pressure—space—performance.

POWER, PROCESS OR HEATING.

NOVEMBER, 1939

JOHNSTON Boilers

JUDICIOUSLY APPLIED TO YOUR PROBLEM

and resulting in improved quality or reduced cost of product or increased output of your plant would mean BIGGER PROFITS FOR YOU.

Our Sales Representatives have accomplished this result for others.

TURN YOUR BOILER PROBLEM OVER TO US.

Johnston Brothers, Inc.

Phone: EL 2-1425 Elizabeth, N. J. 259 N. Broad Street

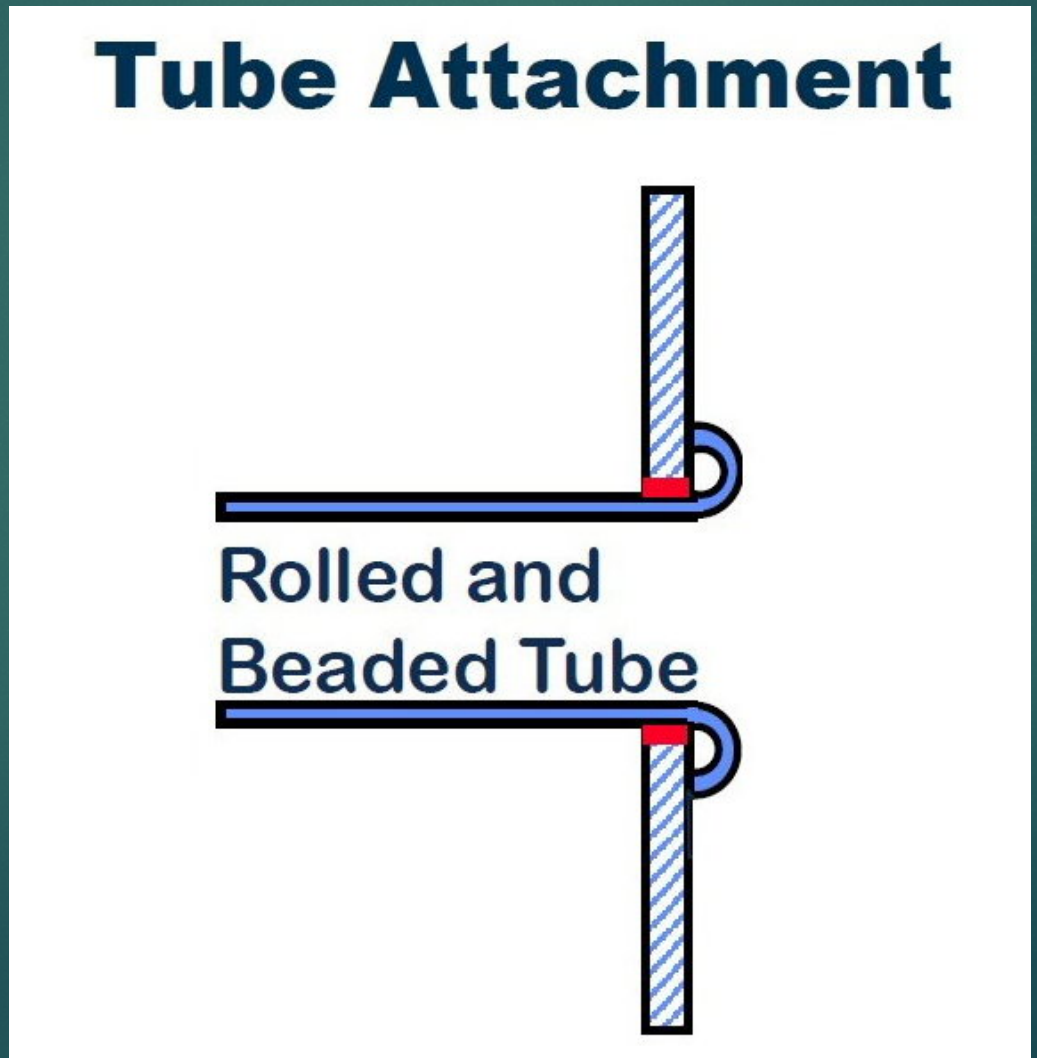
SCOTCH MARINE BOILER – LACK OF INNOVATION

SCOTCH MARINE BOILER TODAY – RIVETS REPLACED BY WELDS



SCOTCH MARINE BOILER

TUBE-ATTACHMENT WITHOUT WELDS



SCOTCH MARINE BOILER

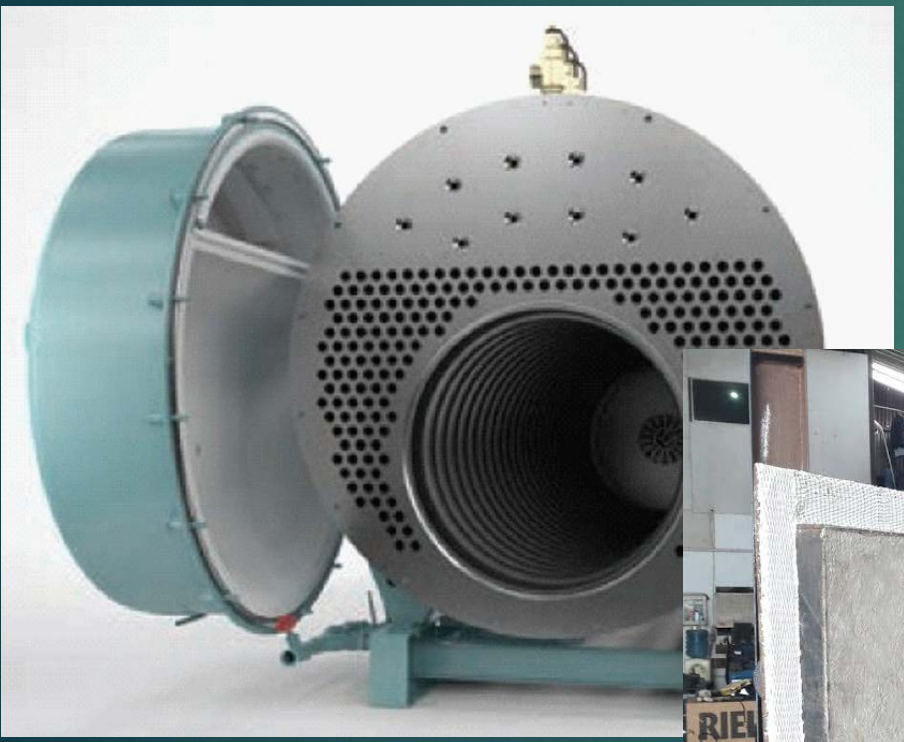
INNER WELDS INSPECTION – CRAWLING THROUGH THE MANHOLE





SCOTCH MARINE BOILER

EXTENSIVE USE OF REFRACTORY







SCOTCH MARINE BOILER

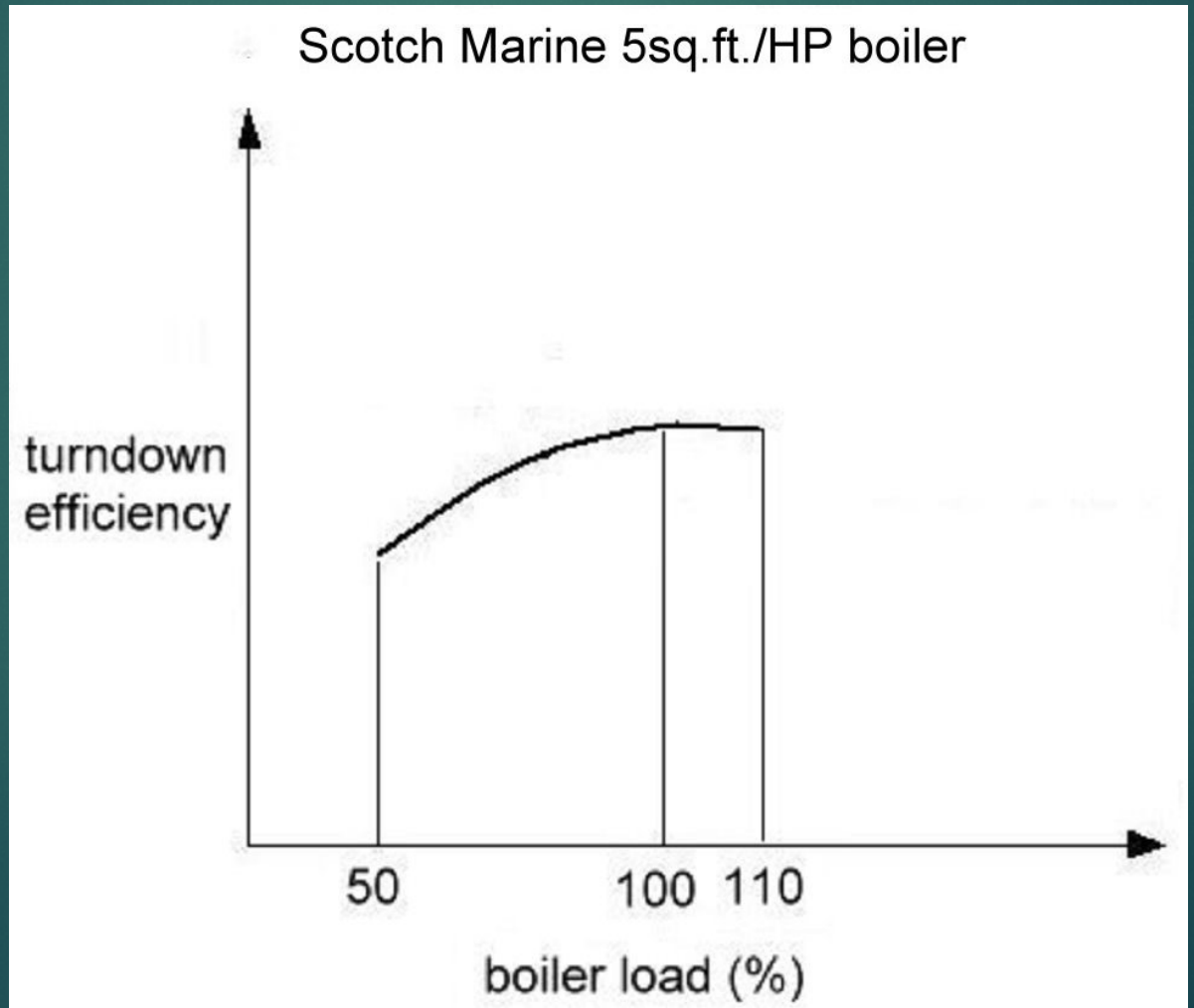
SURFACES TOO HOT TO TOUCH





SCOTCH MARINE BOILER

EFFICIENCY DEGRADATION AT PART LOAD



SCOTCH MARINE BOILER

UNNECESSARY EXCESSIVE TUBE NUMBER



SCOTCH MARINE BOILER

REFRACTORY & TUBE-RELATED REPAIRS COMMONPLACE

NO ROI ON REPAIRS – CLOCK RESET ONLY





SCOTCH MARINE BOILER

FACT

150+ YEARS BEHIND EU-STATE OF THE ART

TIME HAS BEEN STANDING STILL IN THIS AREA IN UNITED STATES

2. INTRODUCING WARGA BOILER

WARGA BOILER

COMPETITIVE ADVANTAGES

- Design rule: Put area where the temp. is & speed up gases
- 4+ times less tubes – 2-pass sub 2sq.ft./HP design
- Industry's first cooled door on steam boiler – no refractory
- Tubes welded – no leak occurrence
- Highest attainable thermal efficiency
- No efficiency degradation at low fire
- All welds easily accessible for inspection
- Token exterior losses
- Maintenance costs reduced to consumables replacement
- Inspection-friendly

WARGA BOILER

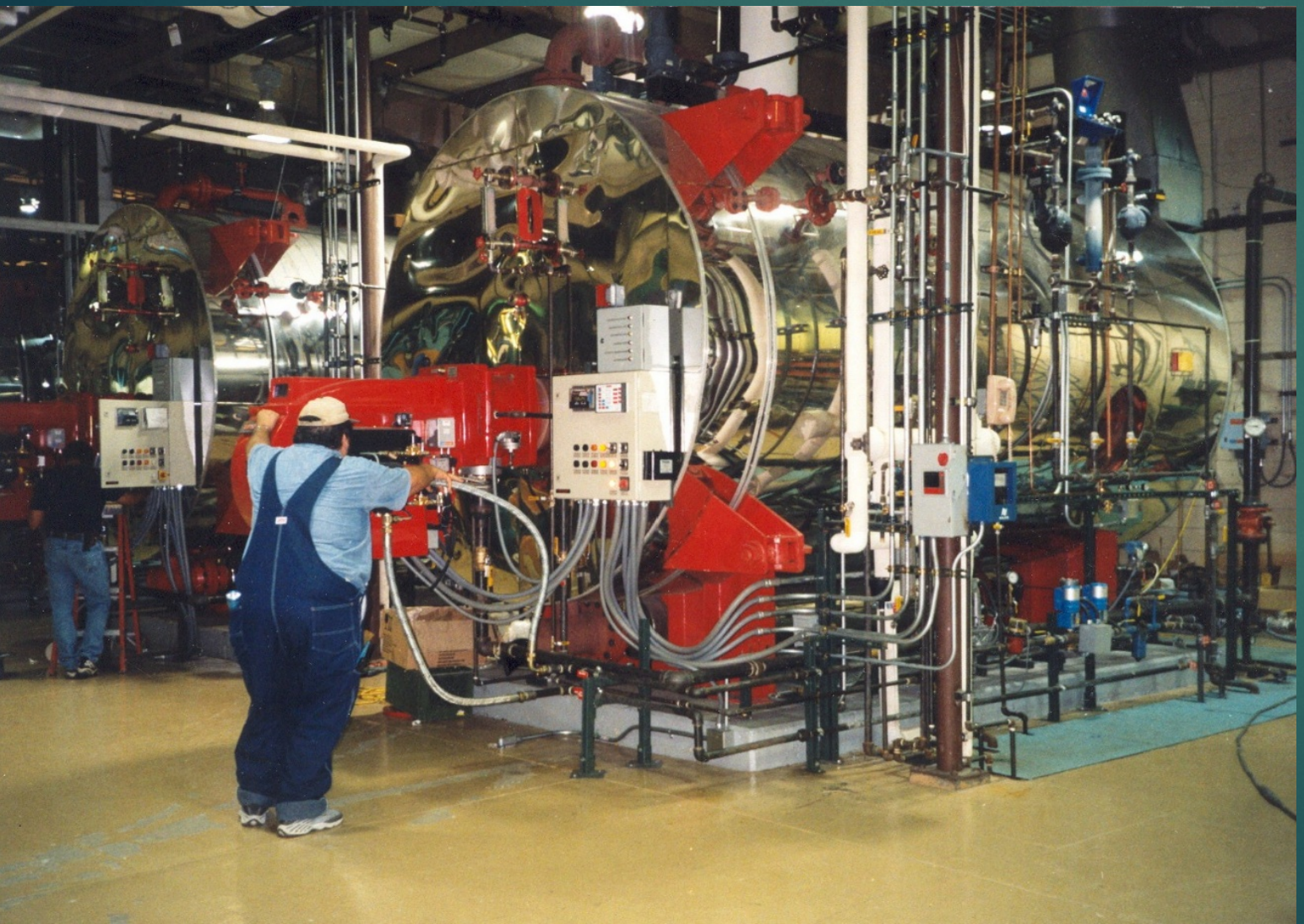
BREAKTHROUGH FEATURE

Possibility to carry out a mandated inspection on the water- and flue-gas side without:

- draining the boiler – thousands of gallons of expensive makeup water saved
- boiler shutdown – boiler continues operating while being inspected
- inspection completed in a single shift

WARGA BOILER IN USA

3 400HP 150PSI STEAM UNITS COMMISSIONED IN 1999





WARGA BOILER IN USA

26TH ANNUAL INSPECTION IN 2025 - NO DEFECTS









WARGA BOILER IN USA

INNER WELDS INSPECTION – NO CRAWLING THROUGH MANHOLE



WARGA BOILER IN USA

27-YEARS SERVICE SUMMARY (2026)

- 20+% fuel usage difference vs. original boilers in the 1st year
- No unscheduled downtime
- No refractory-related costs
- No leaks
- No efficiency degradation at turndown
- Maintenance consisting mostly of consumables replacement
- Sub-4-year ROI

3. WARGA BOILER DESIGN VS SCOTCH MARINE

HEAT TRANSFER ANALYSIS

SAMPLE: SCOTCH MARINE 1200HP BOILER

- 6165 sq.ft. total area – 5sq.ft./HP design
- Number of tubes: 500
- Tubes vs. furnace area: 17:1
- Velocity in tubes (nominal load): 23 mil/h

HEAT TRANSFER ANALYSIS

SAMPLE: WARGA 1200HP BOILER

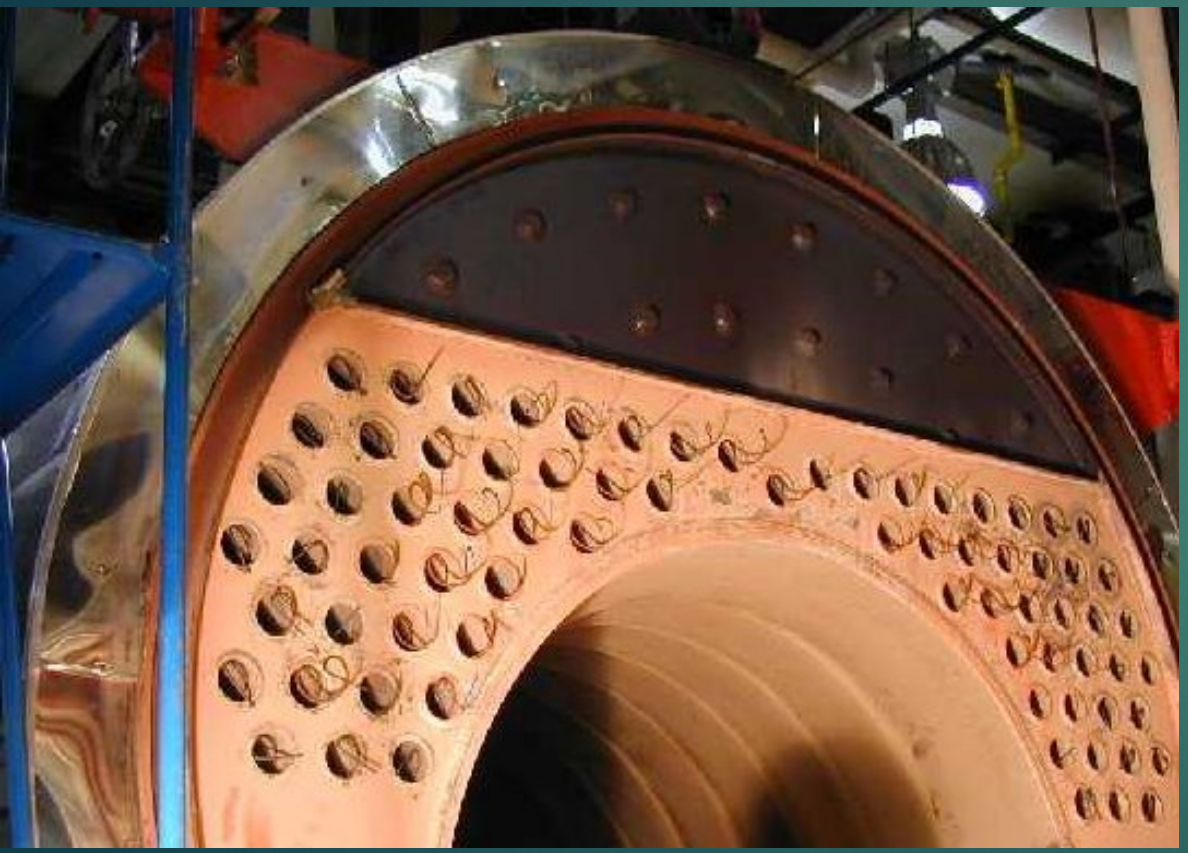
- 2200 sq.ft. total area – 2.8x less with sub 2sq.ft./HP design
- Number of tubes: 130 – 3.8x less
- Tubes vs. furnace area: 2.7:1 – 600% more
- Velocity in tubes (nominal load): 115 mil/h – 500% more

HEAT TRANSFER ANALYSIS

SUMMARY

- Up to 2/3rd less total area with a sub-2 sq.ft./HP design
- Up to 4 times fewer tubes
- Intense heat transfer in tubes

TUBE NUMBER COMPARISON



400HP Warga boiler:
75 tubes

BURNHAM®
Commercial Boilers

LEGEND CONNECTIONS

A = 12" FLANGED SUPPLY (150#)
B = 4" RETURN
C = 3" x 4" HANDHOLE
D = 1" WATER COLUMN
E = 3/4" AQUASTAT
F = 2" BOTTOM BLOWDOWN
G = 2" SURFACE BLOWOFF
H = 2" AUXILIARY CONNECTION
J = 2" SAFETY VALVE (1)
3" SAFETY VALVE (2)
K = 12" x 16" MANHOLE
L = 24" NOMINAL FLUE DIAMETER

RATINGS AND DATA

Shell Diameter : 90"
Gross Output – BHP : 416.5
Gross Output – MBH : 13943
Gross Output – Lbs/Hr : 14370
Net Rating – MBH : 10825
Net Rating – Sq. Ft. : 45105
Safety Valve – Lbs/Hr. : 16000

Heating Surface – Sq. Ft.
Fireside – 2000
Firetubes
Number – 268
Diameter – 2.5" O.D.

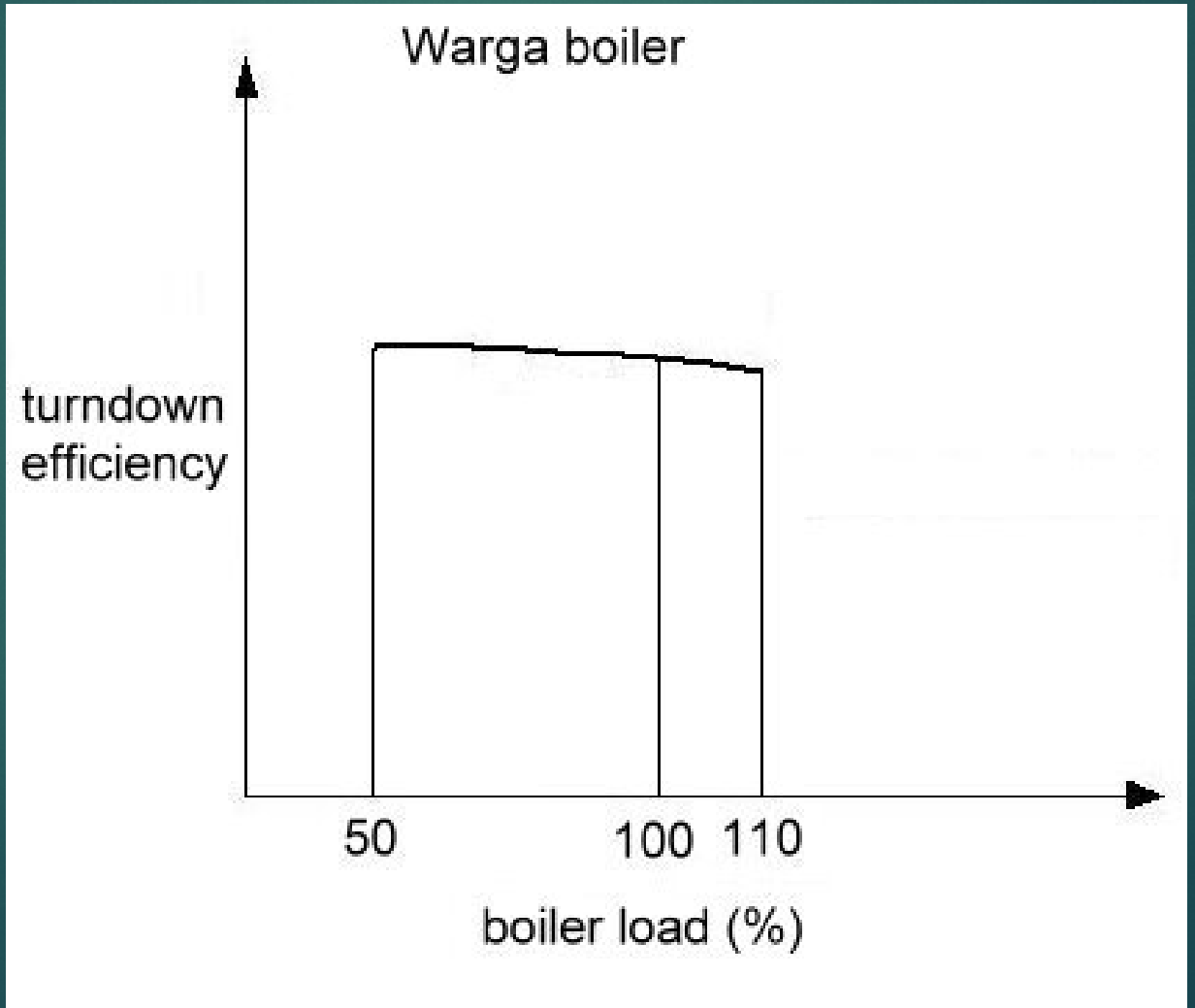
Firing Rate
1000 BTU Gas (MBH) – 16738
140000 BTU/Gal Oil (GPH) – 114.8
150000 BTU/Gal Oil (GPH) – 107.1

Water Content
Pounds – 15599
Gallons (U.S.) – 1873
Approximate Weight/LBS.
Dry – 23200
Wet – 38799

Scotch Marine 5sq.ft-/HP 400HP boiler:
268 tubes – 360% more

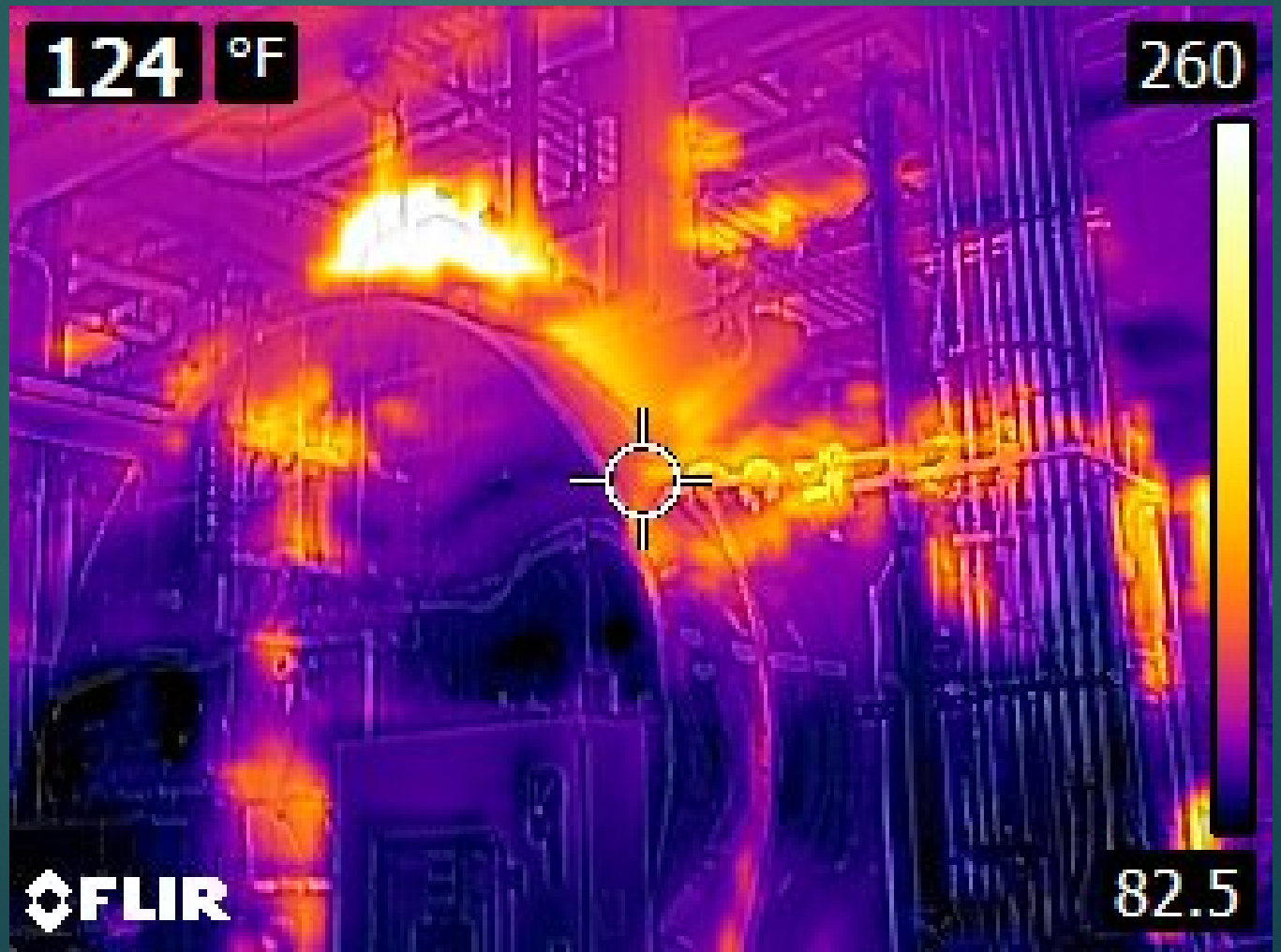
TURNDOWN EFFICIENCY

NO EFFICIENCY DEGRADATION AT LOW FIRE



EXTERIOR LOSSES

TOKEN EXTERIOR LOSSES



SCOTCH MARINE BOILER **AFTER** YEARS OF OPERATION





SCOTCH MARINE BOILER **AFTER** YEARS OF OPERATION





SCOTCH MARINE BOILER **AFTER** YEARS OF OPERATION





WARGA BOILERS AFTER YEARS OF OPERATION



WARGA BOILERS AFTER YEARS OF OPERATION





WARGA BOILERS AFTER YEARS OF OPERATION





WARGA BOILER DESIGN VS SCOTCH MARINE

CONCLUSIONS

1. Highest physically achievable thermal efficiency
2. No efficiency degradation at turndown
3. Up to 4 times fewer tubes in the same-sized boiler
4. Leak occurrence resolved
5. Absence of refractory & related costs
6. Token exterior losses
7. Maintenance costs reduced to consumables
8. Proven & verified in long-term operation in the U.S.A.
9. Lowest inspection costs

4. RETROFIT TO WARGA DESIGN

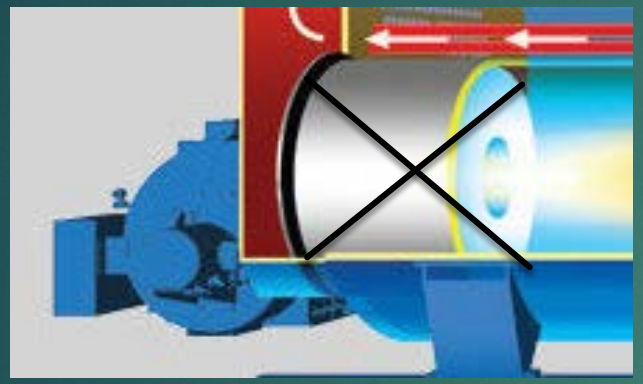
RETROFIT TO WARGA DESIGN

SUMMARY

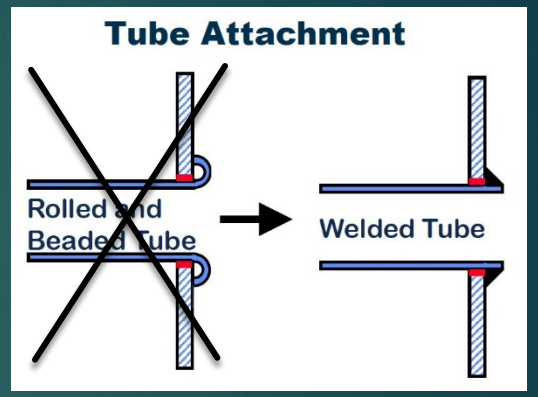
- Procedure developed to upgrade any Scotch Marine boiler to Warga design
- Falls into OPEX category – easier & faster approval process vs CAPEX
- Boiler stays in place & connected
- Procedure is almost non-invasive vs. retubing
- Cost comparable with retubing
- Economic gain pays for investment

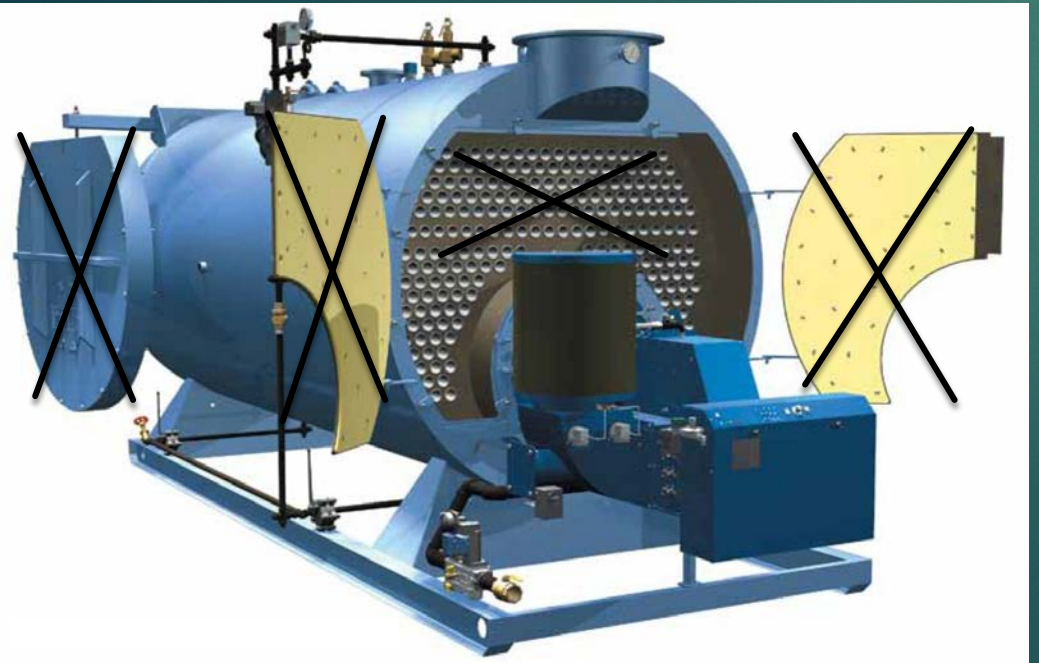
RETROFIT TO WARGA DESIGN

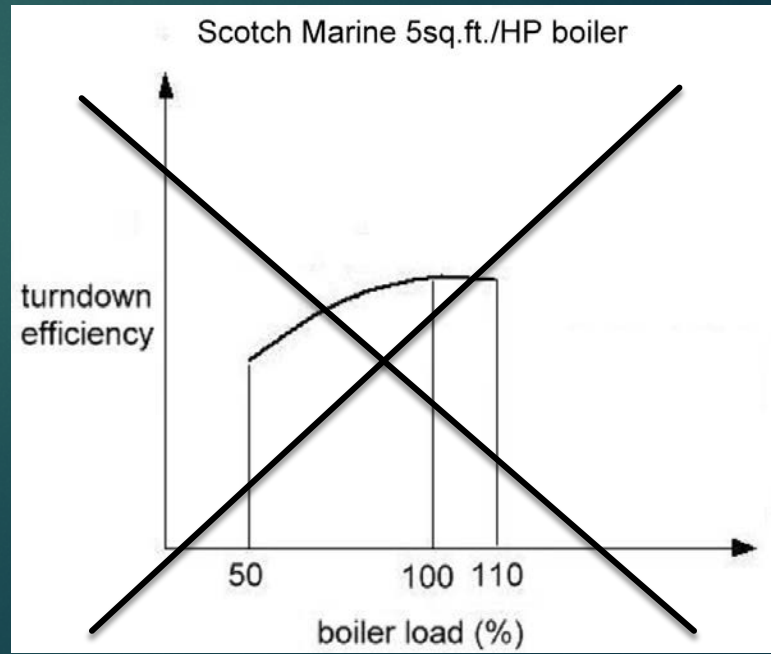
REFRACTORY GONE, FEWER TUBES WITHOUT REMOVAL, LEAKS MITIGATED, MAINTENANCE COSTS MINIMIZED, TOKEN EXTERIOR LOSS, PERFORMANCE BOOST, PAID BACK FROM ECONOMIC GAIN











RETROFIT TO WARGA DESIGN



From THIS



To THIS in just few days

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ELIMINATE COMPROMISE

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