SUPER BOILER

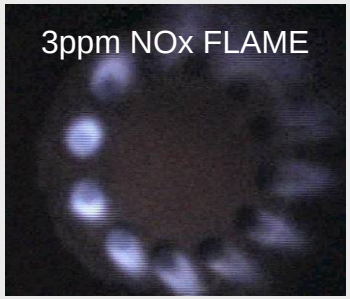
How does it work?

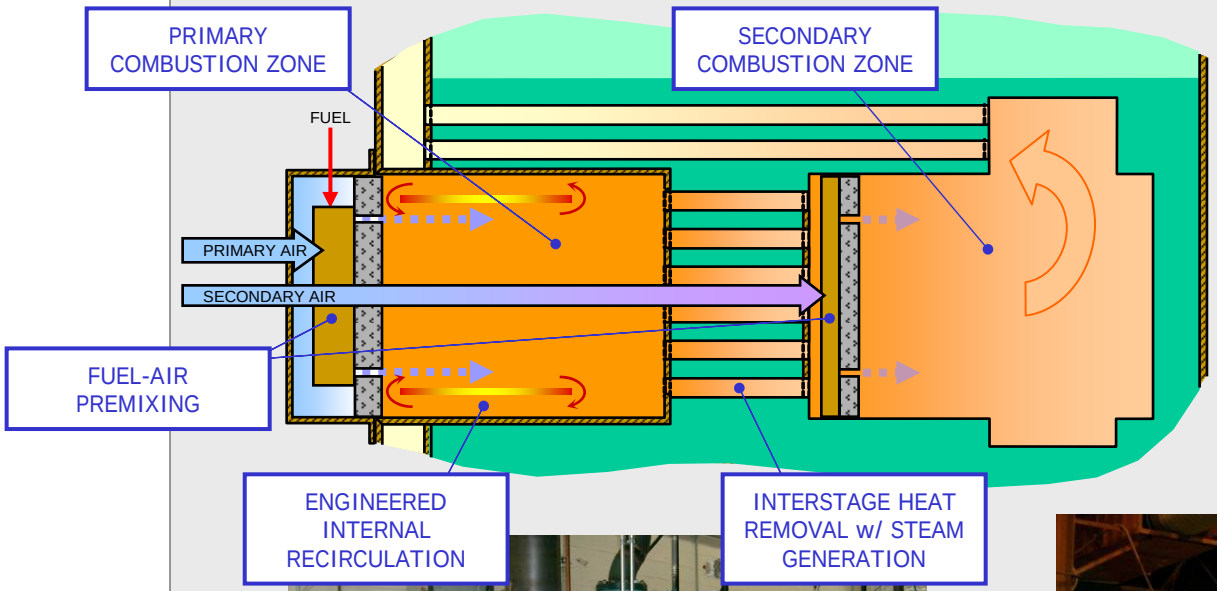
- ✓ Combustion
- ✓ Heat transfer
- ✓ Heat recovery

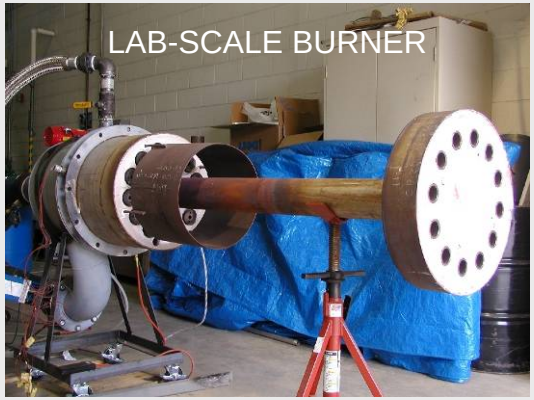
SUPER BOILER
Combustion

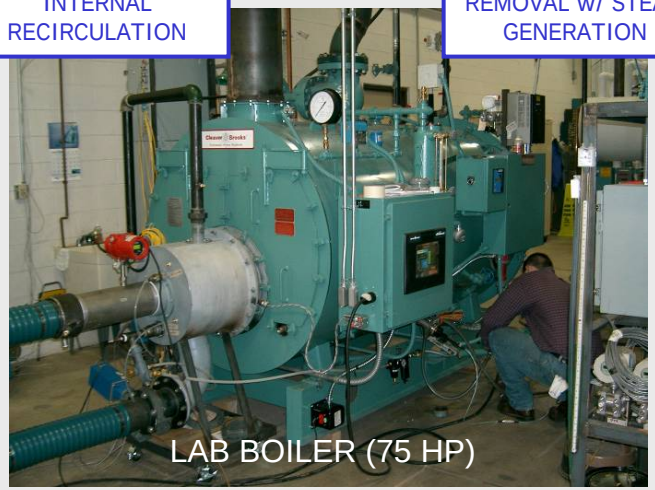
- Natural gas combustion produces heat for steam generation, but also unwanted emissions (NOx, CO, VOC, PM)
- Combustion at low excess air improves energy efficiency
- Minimizing NOx while achieving complete fuel burnout at low excess air is a challenge

SUPER BOILER
two-stage combustion*









* U.S. Patent No. 6,289,851

SUPER BOILER
Heat Transfer

- Heat transfer from fireside to waterside determines boiler size
- Heat transfer rate also determines efficiency up to boiler exhaust outlet
- Increased convective pass heat transfer will reduce boiler size and make downstream heat recovery easier

gti

SUPER BOILER
convective pass tubes

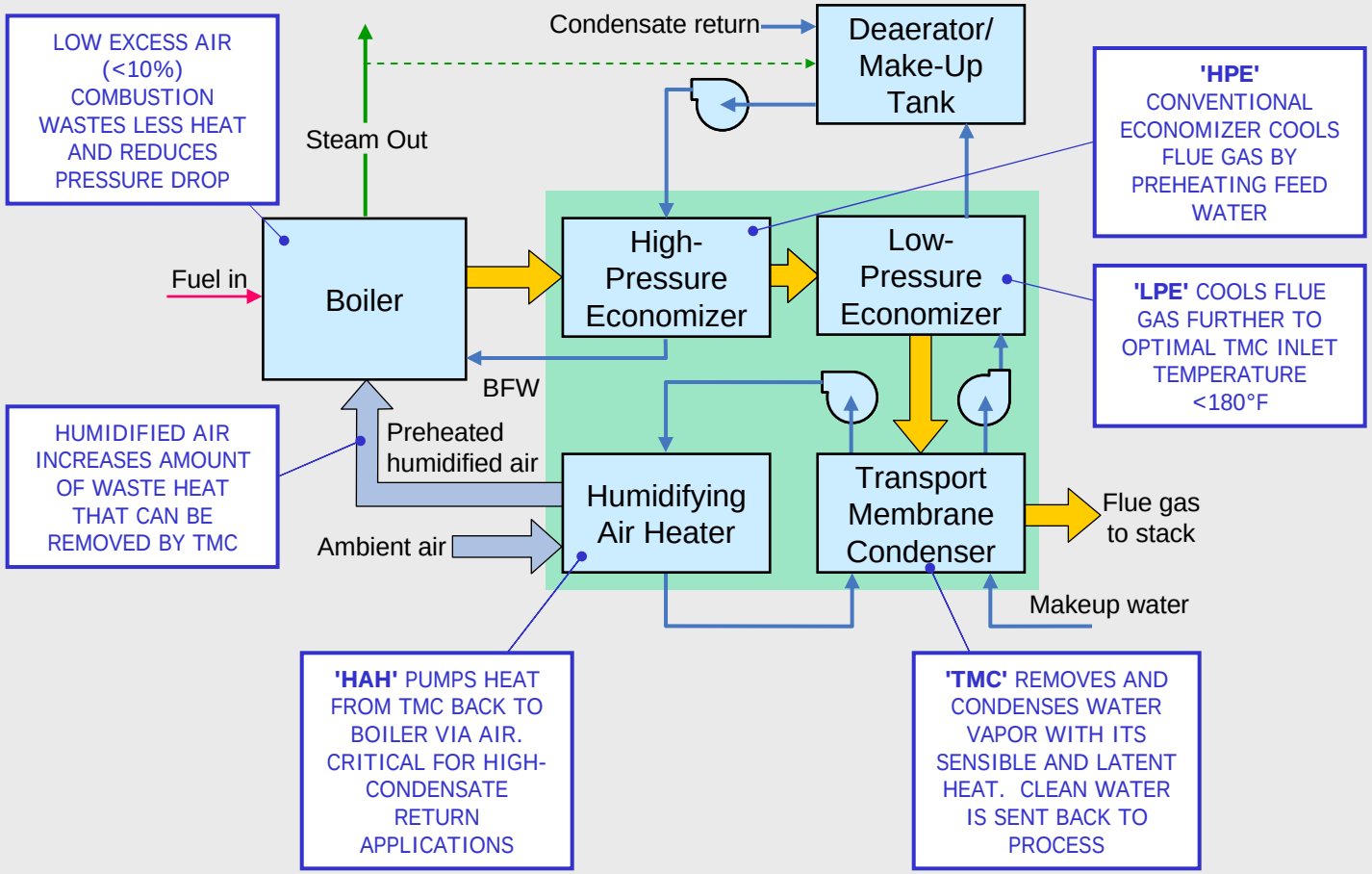
- Enhanced firetube heat transfer
  - Firetubes with extruded aluminum inserts
  - Heat transfer 18X higher than rifled tubes
  - 2-pass boiler can deliver 4-pass efficiency in 30 to 50% smaller size

SUPER BOILER
Heat Recovery

- Natural gas combustion produces about 18% water from oxidation of H in fuel
- Water vapor up the stack accounts for 10% of fuel energy input, or 65% of stack loss
- Key to higher energy efficiency is to recover both sensible *and* latent heat

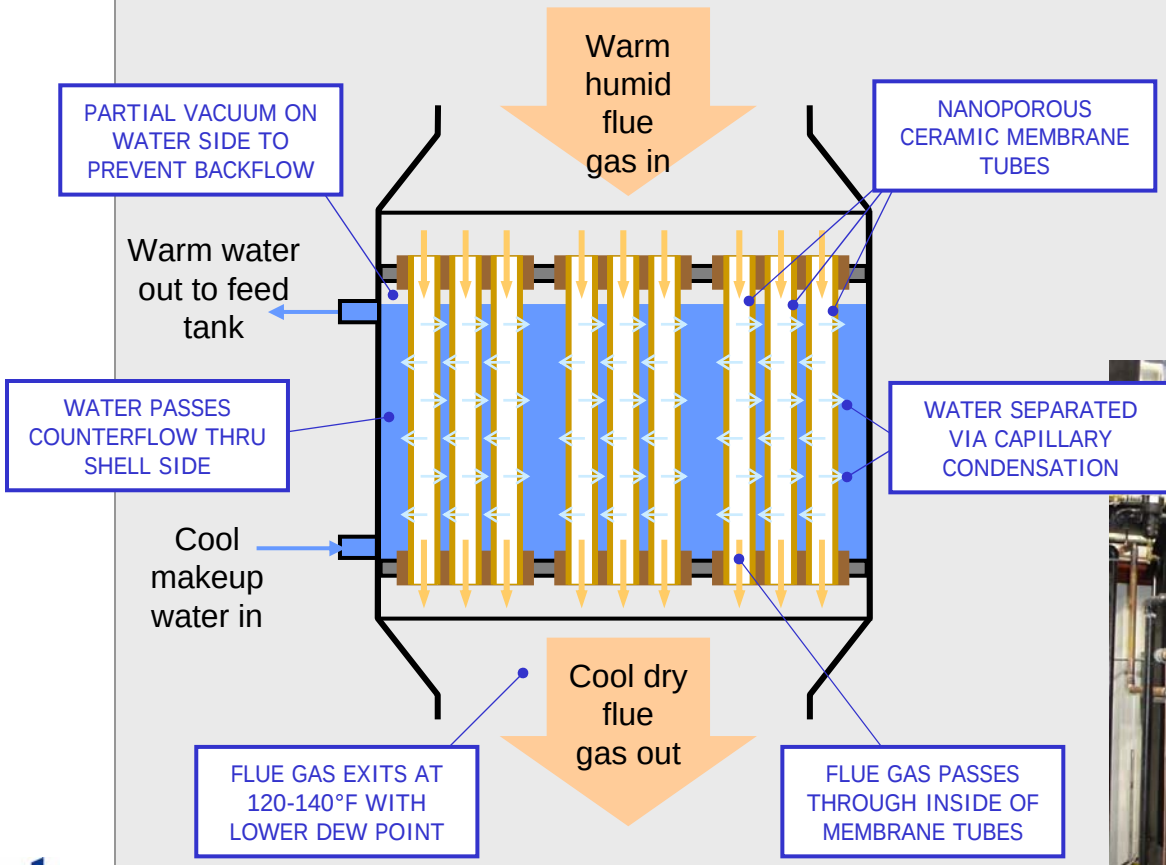
gti

SUPER BOILER
TMC-based heat recovery*



* U.S. Patent No. 7,066,396

SUPER BOILER
TMC detail*

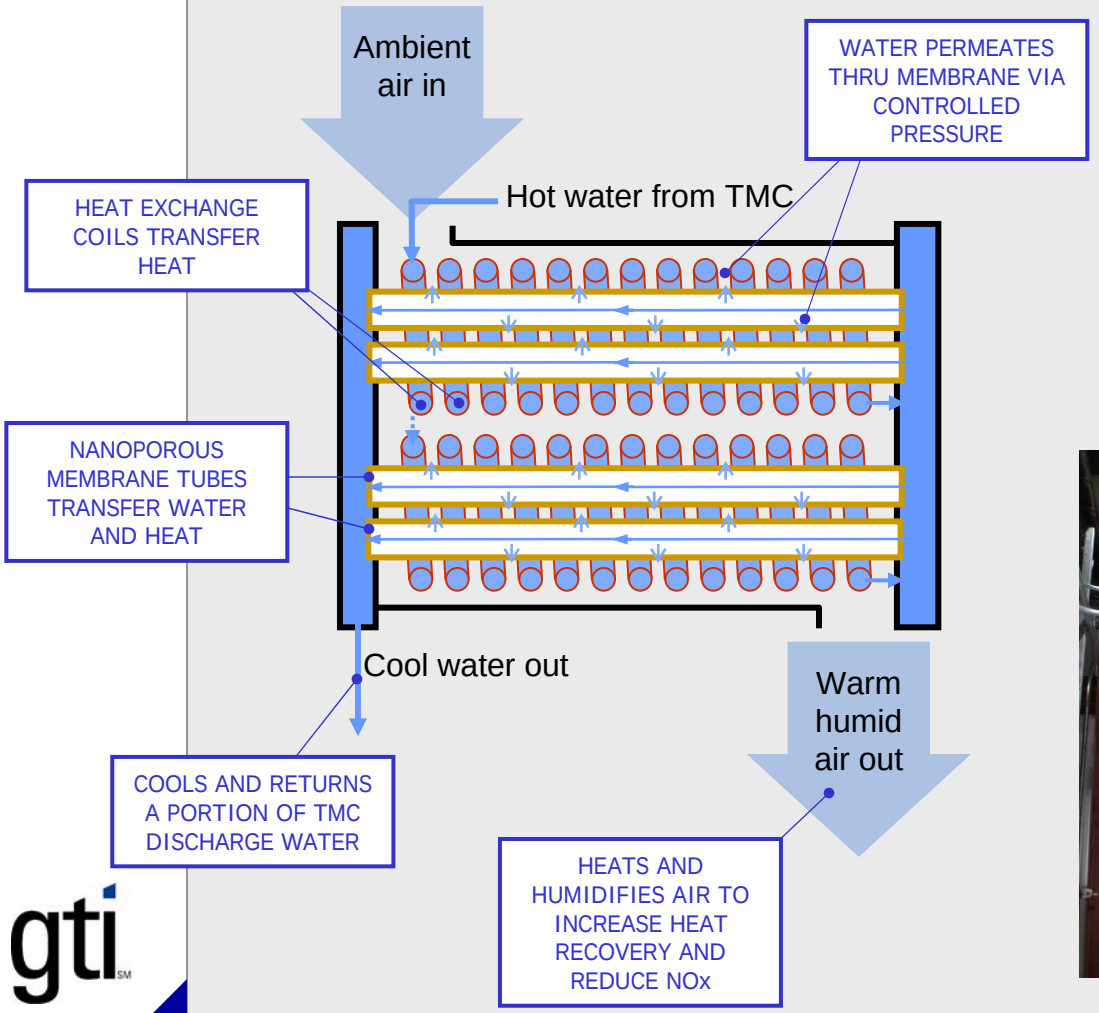



LAB TMC (75 HP)


FIELD DEMO TMC (300 HP)

* U.S. Patent No. 6,517,607

SUPER BOILER
HAH detail



SUPER BOILER
heat recovery controls

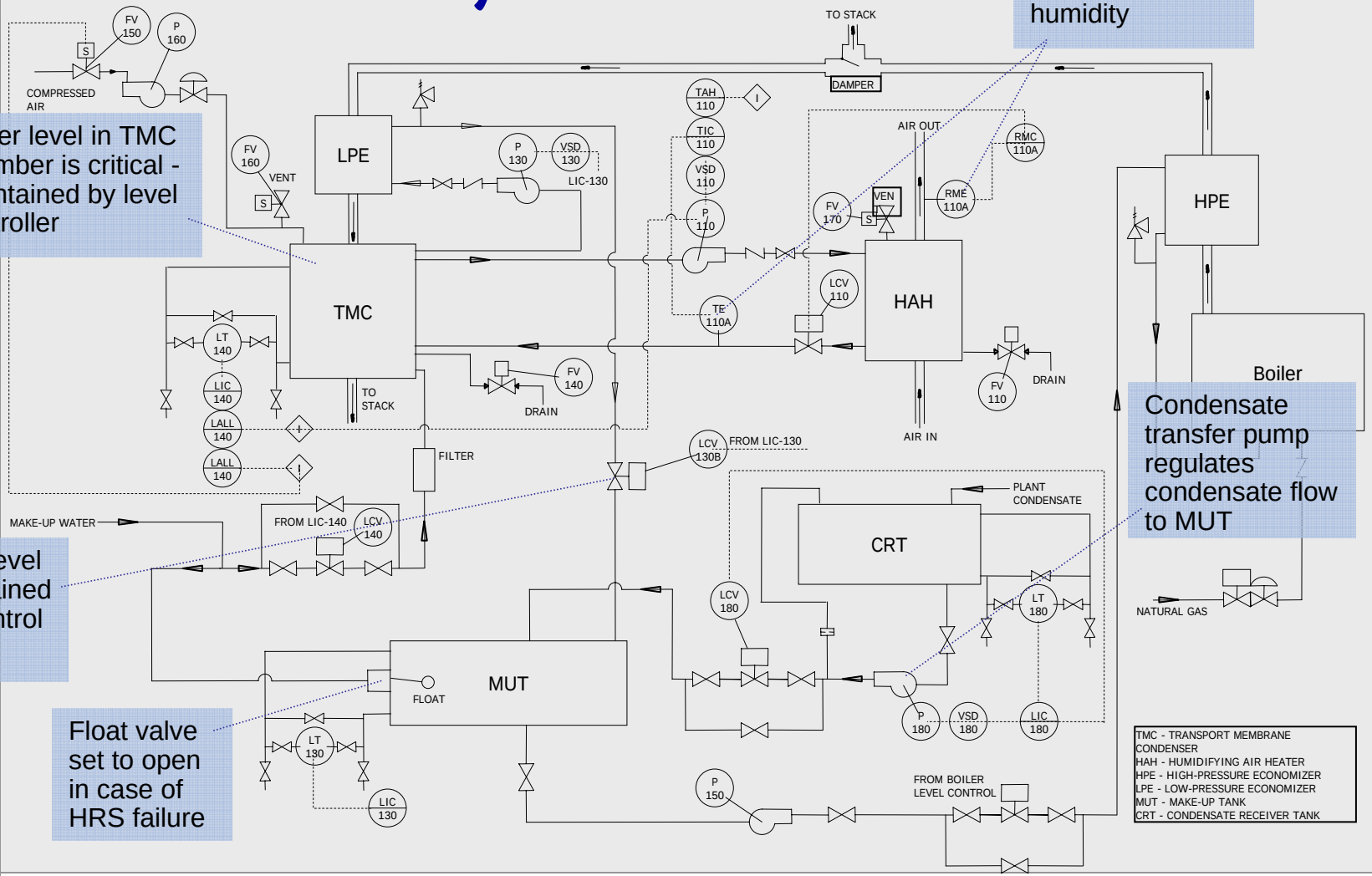
HAH controlled by water temp and exit air humidity

Water level in TMC chamber is critical - maintained by level controller

MUT level maintained via control valve

Float valve set to open in case of HRS failure

Condensate transfer pump regulates condensate flow to MUT



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