Building a Better Boiler

All you need is six serving men...

(though four will probably do)

Why

- Because there is a need for one
- Because it can be done
- Because the steam locomotive will die without it
- Because future generations will not want to burn coal
- Because renewable solid fuels demand it
- Because it is the only way to cut boiler costs substantively
- Because it's fun
- Because it could be more thermally efficient (than what?)
- Because we need to keep the technology cupboard up to date

What

- Staged heating to avoid thermal stresses
- Multifuel capability
- Emissions compliant
- Low exhaust temperature
- Minimal water use
- Maximum thermal efficiency
- Low construction costs and very low costs in use
- Insurer friendly
- User friendly
- You wanna boil some water? This baby has to go anywhere, fit anything, burn rubber even...

What....Part 2

- Maximum sustained rate of evaporation
- Level of superheating
- Optimal output
- Combustion chamber volume
- Firebox/boiler/superheater surface ratios
- Level of in-service heating surface ratio variation required
- Charge air preheat level
- Rate of combustion
- Level of sophistication

Where (to start)

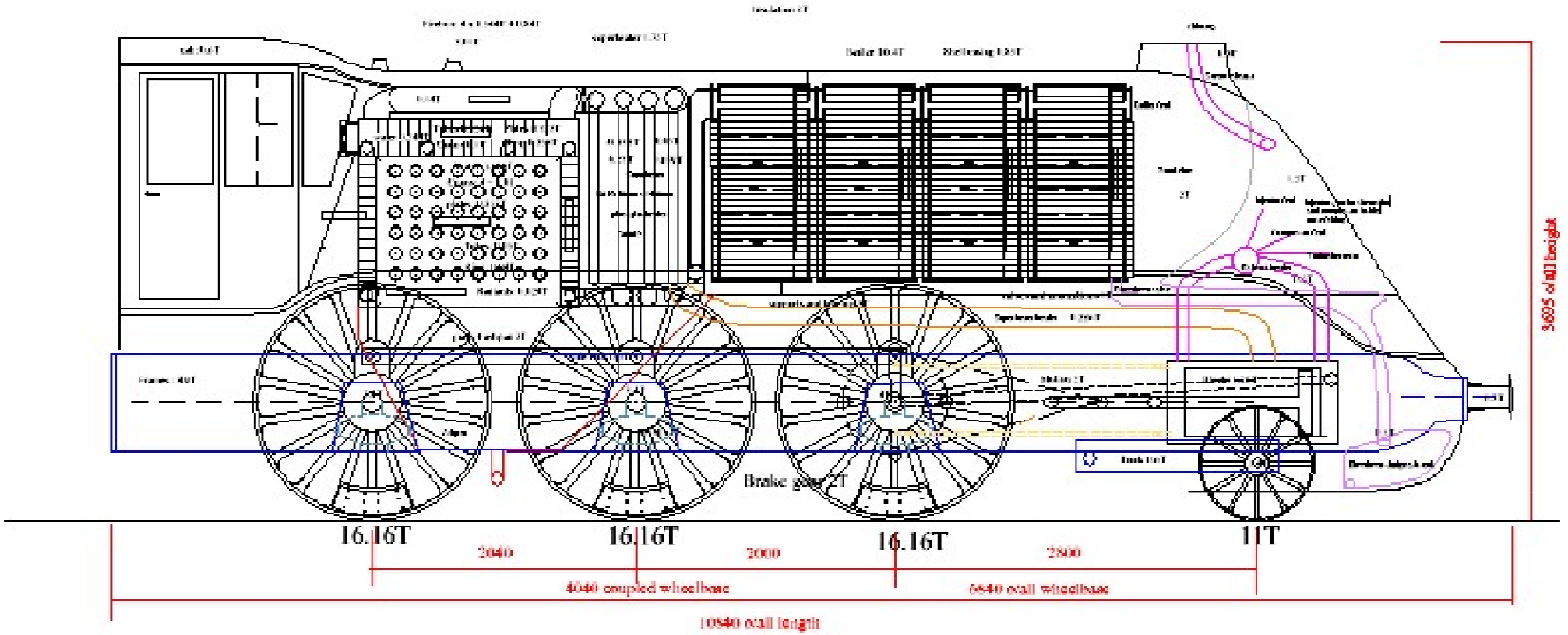
- What have we got to burn?
- What's its energy density?
- Chemical composition...
- Primary and secondary air requirements
- Combustion temperatures
- Grate type(s)
- Combustion chamber
- How is the fire to be fed
- Emissions control – gases and particulates
- Safety

Heat exchange

- Radiant heat utilisation to ensure complete combustion of evolved gases
- Residual radiant heat exchange into water (not steam)
- Convection and conduction heat exchange into water and steam.
- Gas flow temperature gradient paralleled by boiler/superheater/preheater module temperatures
- Discharge gas temperature below 400K
- Provision for condensate energy take off if space permits

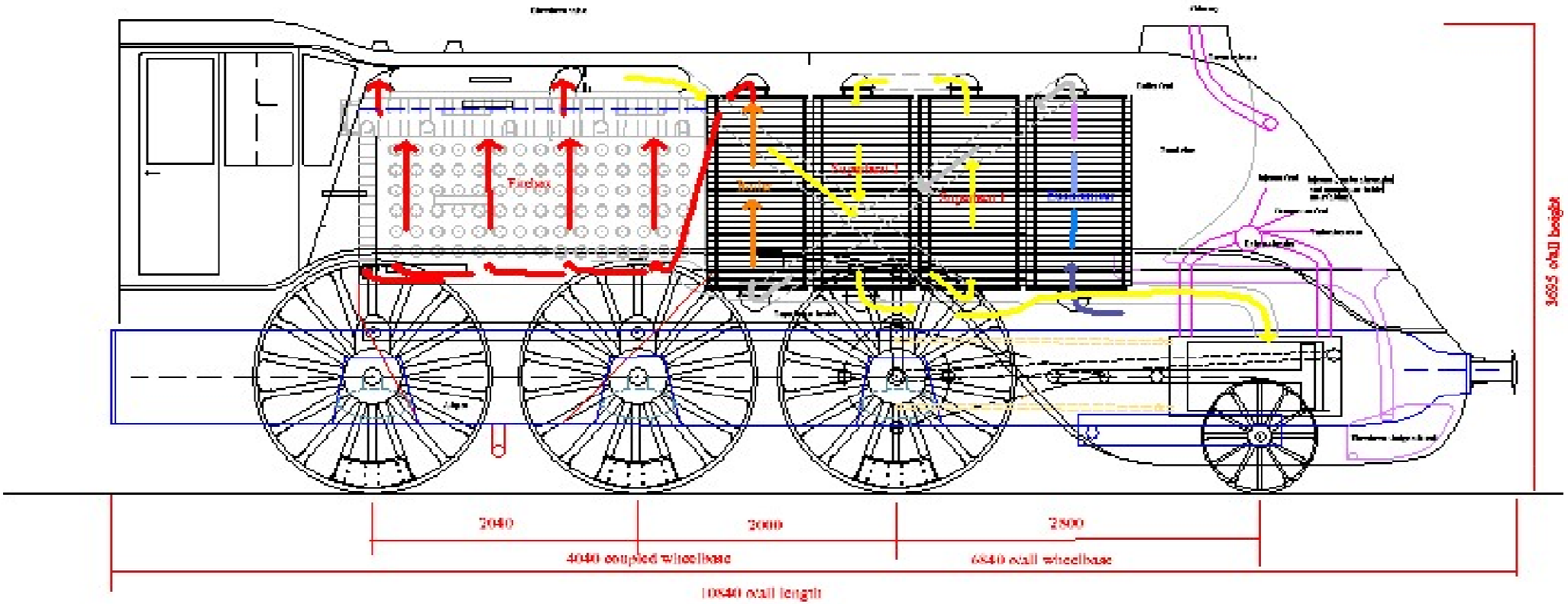
Weight Diagram

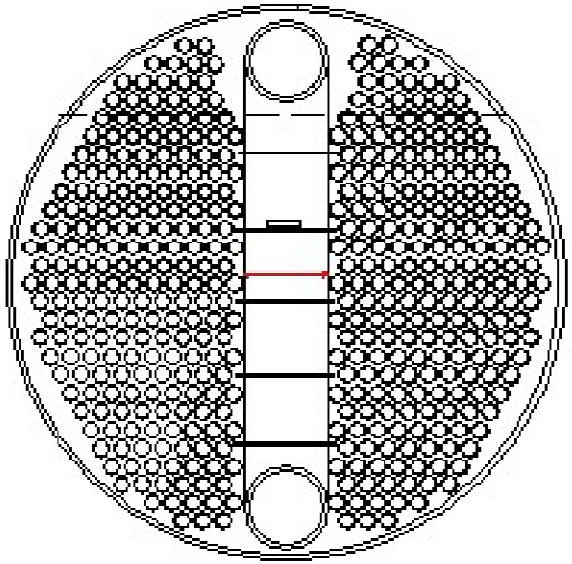
K3-140 General Arrangement



56.086T in w.o. add 5% contingency = 59.486T

K3 General Arrangement





tubes: 815 L x 42.4 x 3.09kg/m = 2.52kg

414 tubes = 1.043T

Baffle plates: 566L x 265W x 5off = 0.054T

End plates: 1500diameter x 10 x 2 off = 0.225T

Shell plates: 3.84m2 = 0.288T

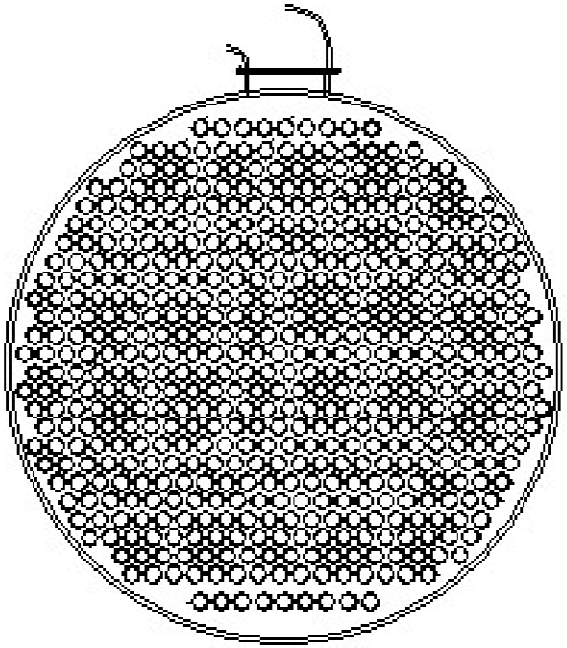
Box sections: 500 girth x 1.5 = 0.056T

Water: 1.767 x .566 = 1m3 - 0.33m3 = 0.66m3 = 660kg

Brackets, etc, say 300kg

494 ft 2

Total: 2.6T approx



500 tubes 40mm - 1.5in nominal bore

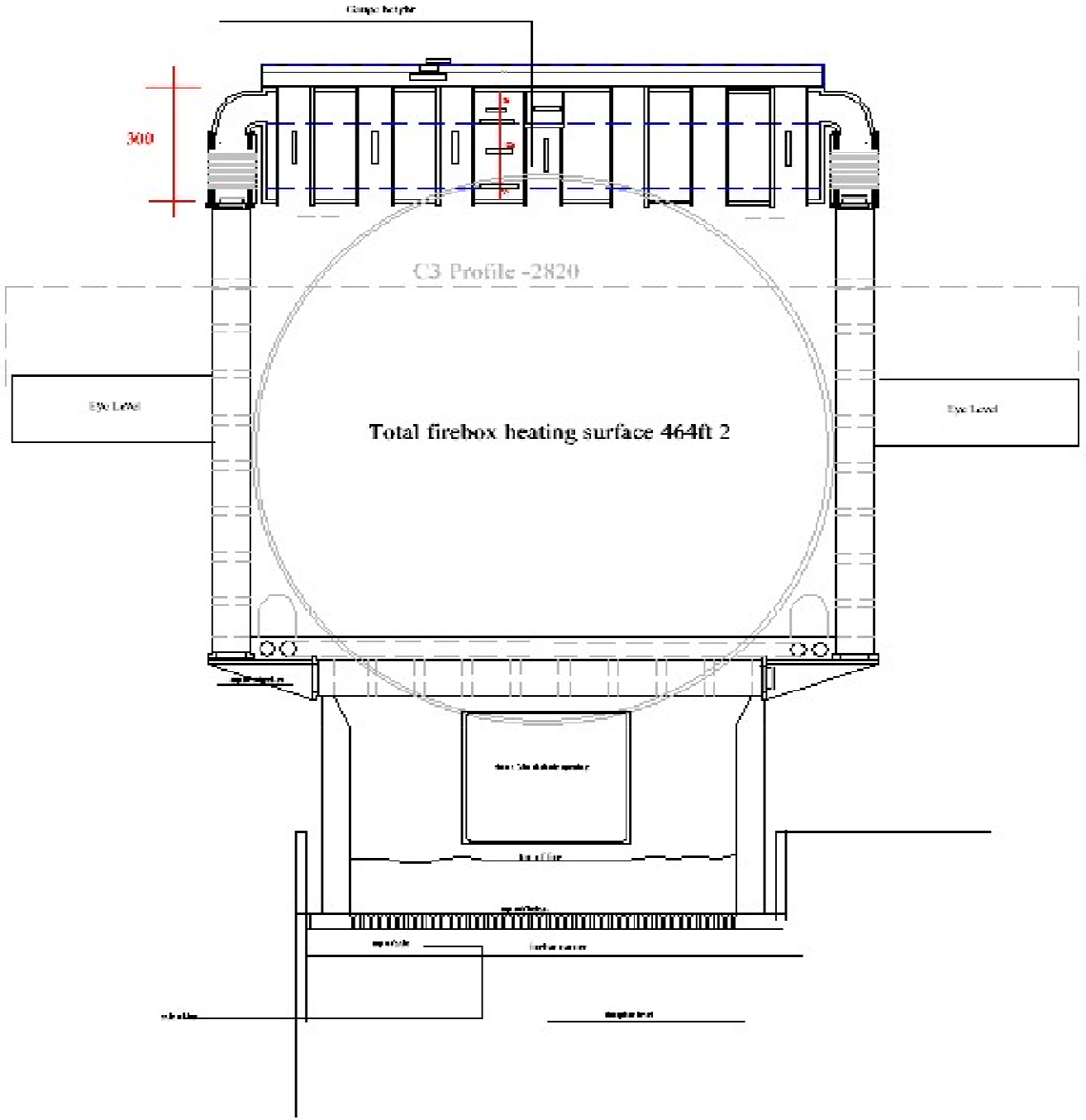
618ft sq heating surface/section

684L nominal capacity: 972g/l - 665Kg @80C, 926g/l - 633Kg @ 140C

Steam - 4.2lKg @150C, 3.89Kg @ 550C184

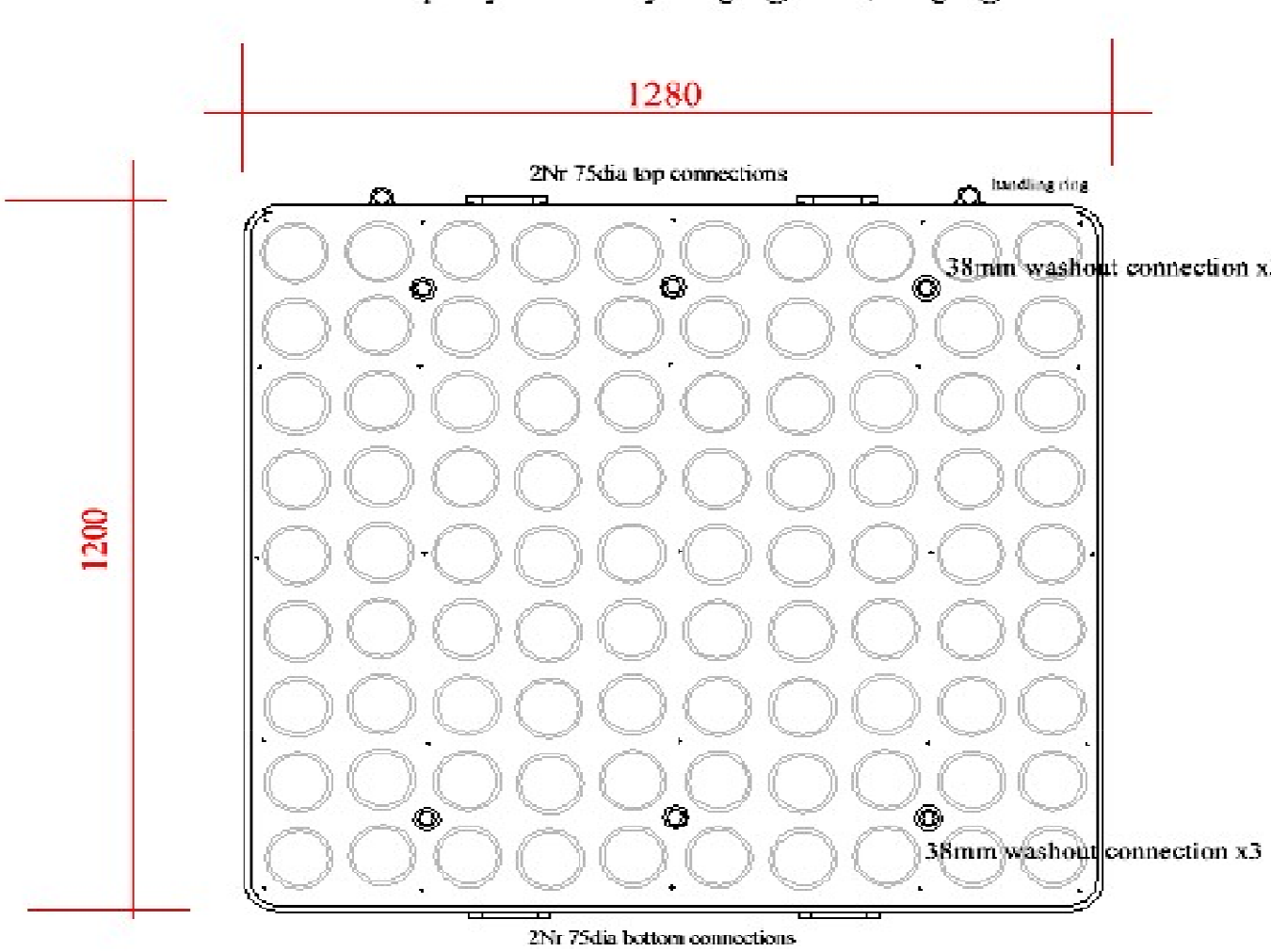
- Keeping the bills small... Money Money Money...
- Never design a new part if you can buy one off the shelf
- Never design a part that can only be made with new equipment
- Look to get production runs rather than one-offs
- Design components so they can be dismantled without damage
- Always do a weight reduction exercise before signing a part off
- Look to eliminate parts that have short life spans
- Keep the size of components down to the smallest that will do the job
- Keep component numbers and differs down.
- Never be afraid to admit that you spent a week chasing a unicorn...
- ...Or even a year
- Never lose sight of the big issues – Heat, Pressure, Fluid Flows.
- Always look to make things idiot proof from the off

Good Lookin'

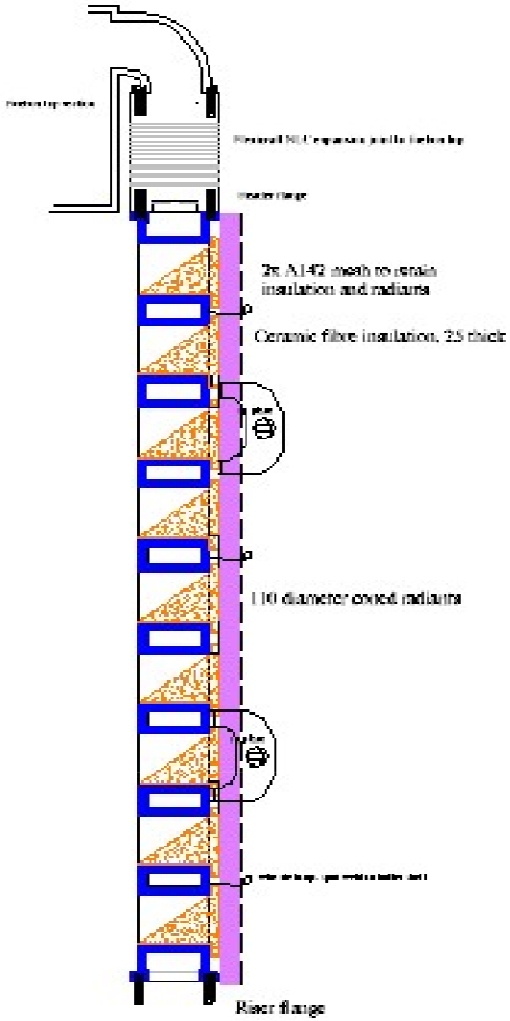


The future is modular...

water capacity 83L density 902g/l @ 140C, 876g/l @ 192C



Firebox back and side - elevation



Section

90 x 100mm fire tubes

23ft2 surface