Power and Water breakout

(mixed results)

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GDE

Nominal Load Table (18.09.06)

AREA SYSTEM	RF	CONV	NC MAGNETS	WATER SYSTEMS	CRYO	EMER	**TOTAL (by Area)**
SOURCES e-	17.86	26.62	3.39	2.54	0.00	0.03	**50.44**
SOURCES e+		1.50	6.78		0.00	0.03	**8.32**
DR	9.33	2.01	9.34	1.00	2.37	0.39	**24.44**
RTML	8.40	3.78	3.22	1.34	2.78	0.15	**19.67**
MAIN LINAC	92.98	22.17	1.41	9.86	32.20	0.40	**159.02**
BDS	0.00	1.11	4.62	3.51	0.24	0.20	**9.68**
DUMPS	0.00	3.83	0.00	0.00	0.00	0.12	**3.95**
TOTAL (by System)	***128.6***	***61.0***	***28.8***	***18.2***	***37.6***	***1.3***	
			USTOPS ~ 180 MW				***275.5***

Definitions (general)

- RF = ‘nearby power distribution’ to klystron
- conv = ‘nearby’ supporting loads
  - **racks, filaments, solenoids, lighting, local pumps**
- NC magnets
- water systems = towers and chillers
- cryo = cold He to cooling tower
- emer = emer. lighting, sump pumps, fire alarm…

US Tech. Options Study (Dugan)

Machine Area	0.5 TeV c.m.	1.0 TeV c.m.
e^+ e^- Injector & acceleration to 5 GeV	2.7	2.9
e^- Damping Ring (1) - 5 GeV 720° Arcs	10.5	10.5
e^+ Damping Rings (2) -5 GeV 720° Arcs	10.5	10.5
e^+ e^- Main Linacs (2) subtotal of below	**132.7**	**295.9**
modulator input power	78.8	167.2
cryo plants	23.2	75.7
klystron auxiliary power	8.4	17.0
magnet power supplies	0.2	0.4
other rack power	3.6	7.3
cryo cooling towers, pumps, fans, auxiliary equipments	4.1	11.0
klystron cooling water pumps	0.6	1.2
cooling towers with pumps and fans	5.1	7.4
ventilation supply, exhaust, chillers	4.6	4.6
lighting, drains, fire protection, ...	4.1	4.1
e^+ e^- IR Transport & Dumps - HE & LE	4.6	4.6
e^+ e^- Interaction Halls (2)	2.6	2.6
Losses in power distribution and motor efficiencies	15.9	28.7
Total	**179.4**	**355.7**

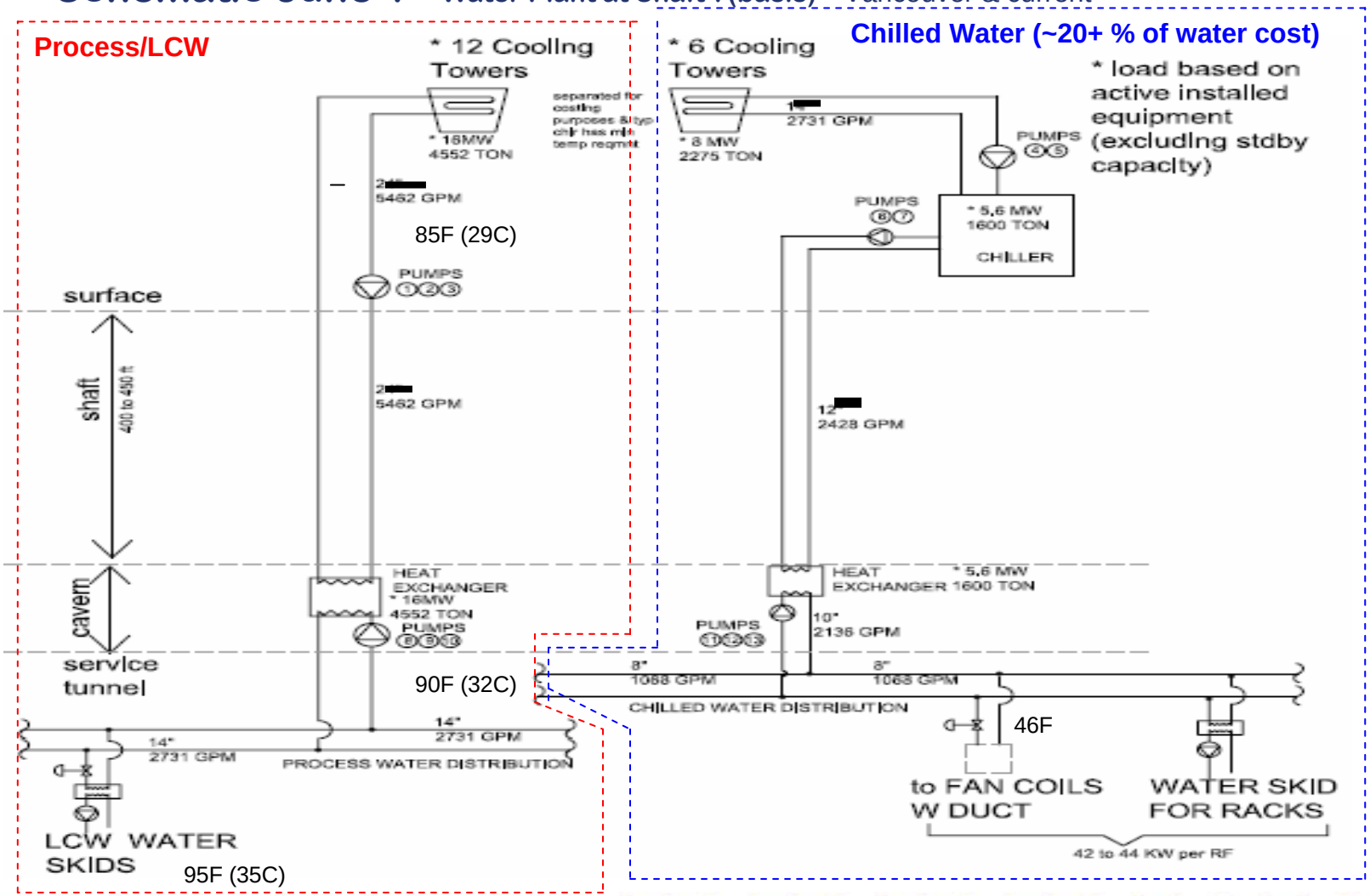
Linac loads

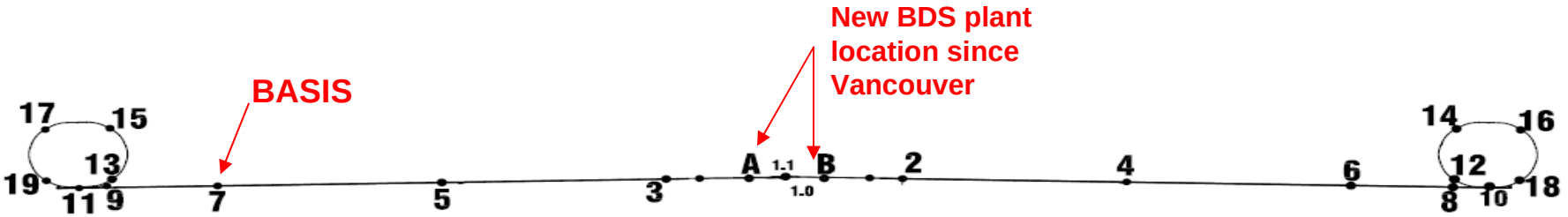
- 93 2 x 10.5 MW beam (22.5%) RF (includes 10% overhead)
- 32 Cryo
- 33 ← support systems (our focus)
- 1.8 quads (?) and emer

- Support Systems:
- 18.6 rack, aux power
- 13.7 cooling
- 0.8 lights

Linac water schematic

- **Schematic June 1 - Water Plant at Shaft 7(basis)** – Vancouver & current





WATER PLANT LOCATION

Plant No.		Area it serves
17	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)
15	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)
19	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)
13	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)
11	RTML	Half of RTML total load
9	e- Source	e- source total load divided by 2 **(wag) Need to be updated per Clay's latest email (need to rearrange distribution later)**
7	ML	Main Linac Total Load x No fo RF at this shaft (128) divided by total no of ML RF (624)
5	ML & e+ source	Same as Shaft 7 (but with 120 total RF) plus half of e+ source total load
3	ML	Same as Shaft 7 (but with 64 total RF) (excluded e+ source transport line for now)
A	BDS and Dump	Half of BDS total load and one 18MW dump

Plant No.		Area it serves
B	BDS and Dump	Half of BDS total load and one 18MW dump
2	ML	Same as Shaft 7 (but with 64 total RF)
4	ML & e+ source & e-	Same as Shaft 5 plus half of e- source load **(wag) Need to be updated per Clay's latest email (need to rearrange distribution later)**
6	ML	Main Linac Total Load x No fo RF at this shaft (128) divided by total no of ML RF (624)
8	RTML	Half of RTML total load
12	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)
14	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)
18	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)
16	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)

Linac Cooling systems

- 6.4 MW chilled water
- 6.1 'process water'
- 1.3 support tunnel dehumidfier (25% recycle)

- Load:
- 26% rejected to air / chilled water ← *targeted*
- 74% to process water

- ~ watt/watt (power to remove dissipated heat)
  - **.29 chilled**
  - **.078 process**
    - (process watt/watt is close to 'standard')
    - will use this as a guideline figure of merit for other systems

Linac – review in process

- Chilled water ‘user’ inventory and reduction
  - **use of chilled water to cool mod supply !!**
- Rack load reduction
  - **e.g. motor holding current (~100 motors / RF unit)**
    - 40% (of 18.6 MW)
- Air temperature requirements
- ‘stacked loads’
- local process water ‘skid’

Draft HVAC 'criteria' (17.09.06)

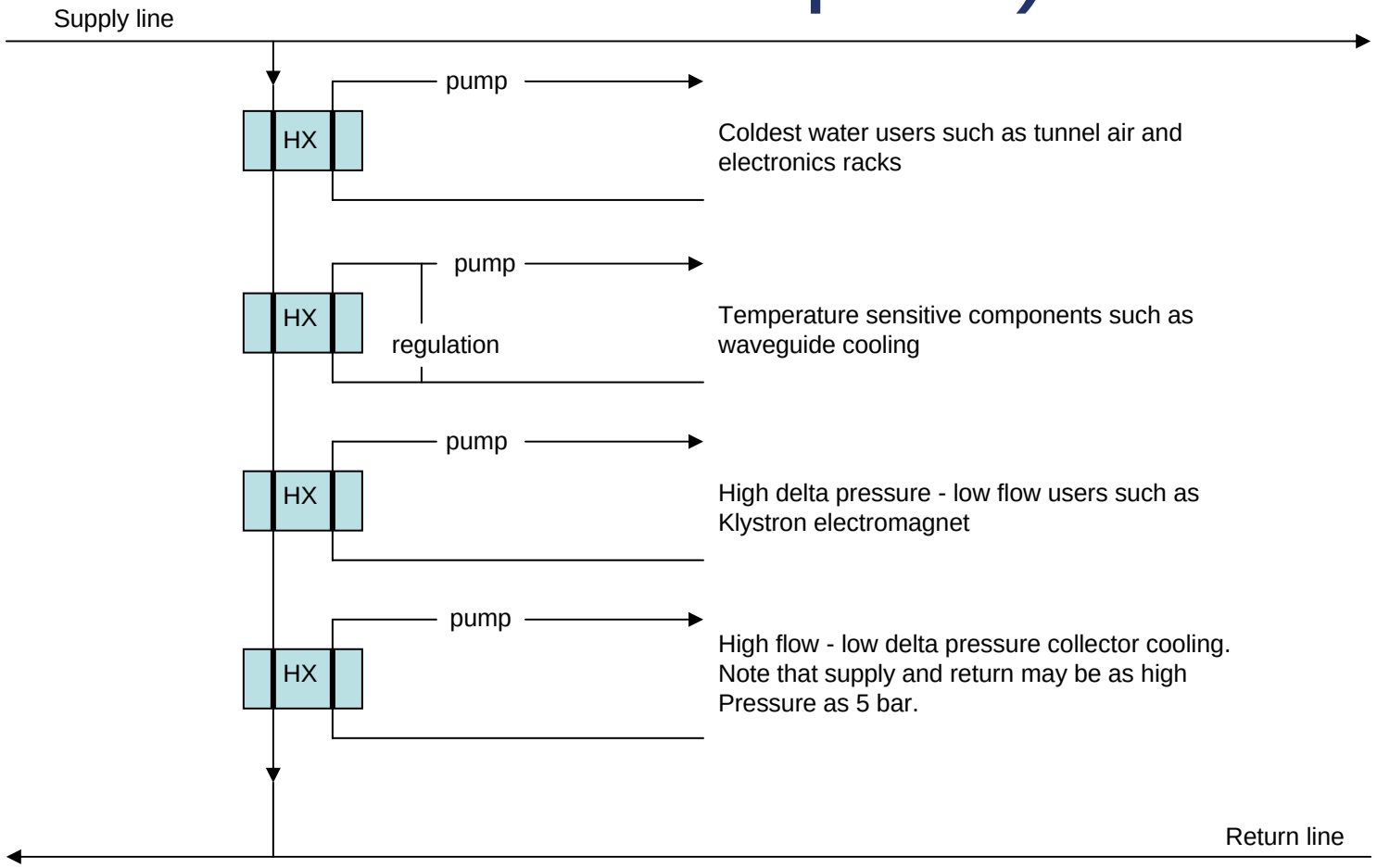
HVAC Criteria

Location	Temperature DB	Dewpoint	Relative Humidity	Air Flow	Comments
-e Source	85F (29C)	<55F (<13C)	<35%	88fpm	Assumed for "Beam Off", no criteria received yet
Damping Ring	104F (40C)	<55F (<13C)	<20%	88fpm	
RTML Service Tunnel	85F (29C)	<55F (<13C)	<20%	88fpm	
Main Linac Service Tunnel/ Beam Tunnel	85F (29C)/ not controlled 85F+	<55F (<13C)	<35%	88fpm	
BDS	104F (40C)	<55F (<13C)	<20%	88fpm	
Experimental Hall	85F (29C)	<55F (<13C)	<35%	88fpm	Assumed for "Beam Off", no criteria received yet

Reductions of the primary cooling plant infrastructure (4 months ago)

- **Stacking heat loads reduces primary loop flows and increases delta-T (both good)**
  - For example: Using coldest water to cool tunnel air and electronics, then cooling waveguides, then the klystron body and electromagnets, and then the collector allows for an increase in the delta-T of the primary cooling loops, reductions of water flow (and pump shaft horsepower), and more efficient towers.
- **Reductions of number of cooling skids can be contemplated. When skid has more discrete loops, the optimal spacing might be different.**
- **Increase all primary cooling pipe diameters to reduce shaft horsepower requirements on water flows. The pumping costs for the primary cooling loops are larger than desired.**

‘Stacked Load’ concept (not adopted)



non-linac loads

- tabulation and evaluation not mature
  - **e.g. e+ changed +31 MW last week and needs review**
  - **I expect this to be removed**
  - **(no ILC w/w number…)**
- BDS:
  - **60 W/m (1 TeV cm)**
    - 4x better for 1/2 TeV
- DR
  - **400 W/m/ring**
- 140 W/m for SLS

DR top level (Wolski)

- 6 weeks old → corrections due (~30%)

Electron Ring					
	Input kW		Output kW		
	wallplug	from beam	to beam	to water	to air
RF Power (base value)	6300	0	3500	2300	500
RF Power (peak overhead)	700	0	0	70	0
Water-Cooled Magnets	1099	0	0	1099	0
Air-Cooled Magnets	109	0	0	0	109
Cables	1377	0	0	0	1377
Magnet Power Supply Losses	364	0	0	0	364
Injection/Extraction Kickers (averag	443	0	0	443	0
Radiation	0	3500	0	2800	700
total (peak)	10392			6712	3050

Goal:

- 200 to 220 MW –
  - **(10 to 20% more than USLCTOPS)**
  - **threshold ~ 5 MW**
  - **reduction of 30 MW from cooling and support loads**
- include duty factor issues (e.g. dump loads)

- NOT studied:
  - **RF, magnets, cryo**