THERMAL LOAD USED (in MW) (..and still changing….) Updated Aug 25 2006 CFS

Area System	LCW	Air / Chilled Water (does not include heat of compression)	**Total**	Sources
SOURCES e-	3.72	1.31	**5.03**	**Aug 21** (Clay) 4.36;3.72;2.53 MW for LCW, 1.53;1.31;0.89 MW for Air- Numbers are PSTD (peak simultaneous thermal demand);INPTC (installed nameplate thermal capacity) ;ATL (Average thermal demand)
SOURCES e+	15.8	5.55	**21.35**	**Aug 21** (Clay) 22.8;15.8;10.7 MW for LCW, 8.00;5.55;3.80 MW for Air - PSTD (peak simultaneous thermal demand) ;INPTC (installed nameplate thermal capacity);ATL (average thermal demand)
DR e-	6.71	3.05	**9.762**	**Aug 10** (Andy)-except load to air is not used (which is assume to be dissipated to ventilation air) LOADS STILL NEED TO BE CHECKED WITH MAGNET GROUP --very preliminary accdg to Andy
DR e+	8.25	4.90	**13.154**	**Aug 10** (Andy)-except load to air is not used (which is assume to be dissipated to ventilation air) LOADS STILL NEED TO BE CHECKED WITH MAGNET GROUP --very preliminary accdg to Andy
RTML	12	2.4	**14.4**	**May 24** (Jerry, PT) preliminary ~7 MW per RTML
MAIN LINAC	78	26.83	**104.832**	**Jun 1** (Shigeki et. al.) spreadsheet per RF x 624 RF
BDS	14.71	2.60	**17.3**	**Aug 10** (Andrei) Rough 17.3 MW for 14mrad---TO BE CHECKED---very very preliminary accdg to Andrei. Assume 85%/ 15% distribution to lcw/air
DUMPS	36	0	**36**	**Aug 15** (Andrei) -reconfigure such that one or two plant sized for(2) 18MW serves (6) 18MW dumps, only (2) are active at any time. **Aug 25** (Fred), adjust shaft locations
	175	*49*	**222**	

Aug 21 2006 **(DRAFT DRAFT - TO BE CONFIRMED WITH MAGNET GROUP PER AW)**

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Electron Ring

	Input kW		Duty factor	Output kW			
	wallplug	from beam		to beam	to water	to air	
RF Power (base value)	6300	0	1.00	3500	2300	500	alcoves
RF Power (peak overhead)	700	0	0.10	0	70	0	tunnel beampipe
Water-Cooled Magnets	1099	0	1.00	0	1099	0	tunnel dipoles + quadrupoles + septa
Air-Cooled Magnets	109	0	1.00	0	0	109	tunnel sextupoles + orbit correctors + skew quadrupoles
Cables	1377	0	1.00	0	0	1377	tunnel
Magnet Power Supply Losses	364	0	1.00	0	0	364	alcoves
Injection/Extraction Kickers (average pow	443	0	1.00	0	443	0	tunnel pulsed power - 443 kW average
Radiation	0	3500	1.00	0	2800	700	tunnel
total (peak)	10392				6712	3050	

Positron Rings (total for two rings)

	Input KW		Duty factor	Output kW			
	wallplug	from beam		to beam	to water	to air	
RF Power (base value)	6300	0	1.00	3500	2300	500	alcoves
RF Power (peak overhead)	700	0	0.10	0	70	0	tunnel beampipe
Water-Cooled Magnets	2198	0	1.00	0	2198	0	tunnel dipoles + quadrupoles + septa
Air-Cooled Magnets	218	0	1.00	0	0	218	tunnel sextupoles + orbit correctors + skew quadrupoles
Cables	2754	0	1.00	0	0	2754	tunnel
Magnet Power Supply Losses	728	0	1.00	0	0	728	alcoves
Injection/Extraction Kickers (average pow	886	0	1.00	0	886	0	tunnel pulsed power - 886 kW average
Radiation	0	3500	1.00	0	2800	700	tunnel
total	13784				8254	4900	

Aug 17 2006

WATER AND AIR HEAT LOAD

MAIN LINAC - ELECTRON & POSITRON

Components	Quantity Per 36m	Location	Total Heat Load (KW)	To Deionized Water: Heat Load to Water (KW)	Supply Temp (variation) (C)	Delta Temperature (C delta)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C	to Chilled Water: Heat Load to Water (KW)	To Air: Heat Load to Air (KW)	Max Space Temp (C)	Source
LCW Skid Pump 5 Hp (placehodler)	1	Service Tunnel	4.14	0	N/A	N/A	N/A	N/A	None	0	4.14		* emil - 5 HP pump placeholder
Fancoils (5 ton Chilled Water) 1 Hp	2	Service Tunnel	1.66	0	N/A	N/A	N/A	N/A	None	0	1.66		* emil - (2) 1HP 5Ton Fancoil placeholder
Rack Water Skid	0.25	Service Tunnel	1.04	0	N/A	N/A	N/A	N/A	None	0	1.04		* emil - 1(5Hp) every 4 RF (placeholder)
Lighting Heat Dissipation ~1.3W/sf		Service Tunnel	1.65	0	N/A	N/A	N/A	N/A	None	0	1.65		* Clay - 14 W per sq m
Lighting Heat Dissipation ~1.3W/sf		Accelerator Tunnel	1.65	0	N/A	N/A	N/A	N/A	None	0	1.65		* Clay - 14 W per sq m
People Heat Dissipation 500btuh each	0	Accelerator Tunnel	0.00	0	N/A	N/A	N/A	N/A	None	0	0.00		* emil - placeholder
People Heat Dissipation 500btuh each	2	Service Tunnel	0.29	0	N/A	N/A	N/A	N/A	None	0	0.29		* emil - placeholder
AC Pwr Transformer 34.5-.48 kV	0.25	Service Tunnel	2.00	0	N/A	N/A	N/A	N/A	None	0	2		* Clay email 3-14-06 typical 112.5 kVa oil xfmr
Emerg. AC Pwr Transformer 34.5-.48 kV		Service Tunnel	1.00	0	N/A	N/A	N/A	N/A	None	0	1.3		* Clay email 3-14-06 typical 75 kVa oil xfmr
RF Charging Supply 34.5 Kv AC-11KV DC	1/36 m	Service Tunnel	**19.00**	**7.50**						0	**11.5**		* C.Jensen email 2-27-06 183 kVa 0.84pf oil ps xfmr **Shigeki Apr 18 2006 **** Clay 5-25-06 LLRF meeting**
Modulator		Service Tunnel	7.50	3.50			28.8			0	**4**		* Shigeki Fukuda Email 3-1-06 **Shigeki Apr 18 2006
Pulse Transformer		Service Tunnel	6.00	5.00						0	**1**		**Shigeki Apr 18 2006
Klystron Socket Tank		Service Tunnel	1.00	1.00						0	**0**		**Shigeki Apr 18 2006
Klystron Focusing Coil		Service Tunnel	8.40	8.40	*34>					0	0		* Shigeki Fukuda Email 4-05-06
Klystron Collector		Service Tunnel	61.00	61.00	*35>			2		0	0		* Shigeki Fukuda Email 3-1-06
Klystron Body		Service Tunnel	10.00	10.00	*35>			5	None	0	0		* Shigeki Fukuda Email 3-1-06
Klystron Windows		Service Tunnel	0.50	0.50	*35>			1		0	0		* Shigeki Fukuda Email 3-1-06
Relay Racks		Service Tunnel	13.3	0.0	N/A	N/A	N/A	N/A	None	12.8	**0**		* Shigeki Fukuda Email 3-30-06 **Shigeki Apr 18 2006 (chilled water) **** Ray larsen Email 8-16 2006**
Circulators & Dummy Load		Accelerator Tunnel	24.3	24.3						0	**0**		**Shigeki Email Apr 28 2006
Waveguide		Accelerator Tunnel	4.00	4.00	N/A	N/A		N/A		0	0.00		* Shigeki Fukuda Email 3-30-06
Other components?????		????								0	0	N/A	
Total			168.4	125.2						12.80	30.23		
RF Component only Loads			154.95										

Total Heat load to Air & Chilled water per RF	**43.0 KW**	47.804	1.62683	5.718319167	29.8775
Total Heat load to LCW per RF	**125 KW**	7.03	3.25375	11.43693125	

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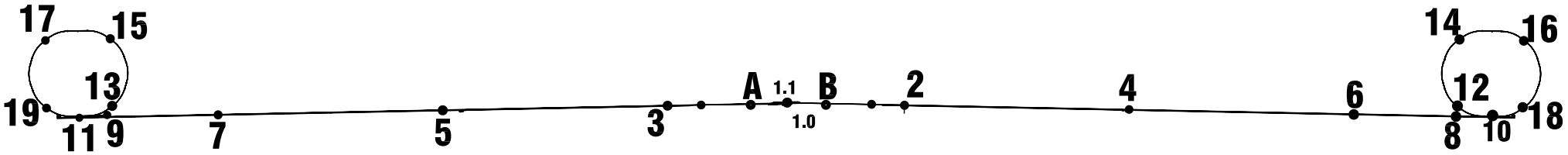
Water Plant Locations & Load/Cost Multiplier

Aug 28 2006

PLANT	Area System Served	How the loads are distributed	LOADS DISTRIBUTION (MW)		Multiplier for	
			LCW/process	AIR/Chw *	Process	Chw
17	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)	1.678	0.216	10%	4%
15	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)	1.678	0.216	10%	4%
19	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)	1.678	0.216	10%	4%
13	e- DR	e- DR load total divided by 4 (except for chilled water only the alcoves are considered)	1.678	0.216	10%	4%
11	RTML	Half of RTML total load	6	1.2	38%	22%
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)**	1.86	0.66	12%	12%
7 (Uee as BASIS)	ML	Main Linac Total Load x No fo RF at this shaft (128) divided by total no of ML RF (624)	16	5.50	100%	100%
5	ML & e+ source	Same as Shaft 7 (but with 120 total RF) plus half of e+ source total load	22.90	7.9	143%	144%
3	ML	Same as Shaft 7 (but with 64 total RF)	8	2.8	50%	50%
A	BDS and Dump	Half of BDS total load and one 18MW dump	25.35	1.30	158%	24%
B	BDS and Dump	Half of BDS total load and one 18MW dump	25.35	1.30	158%	24%
2	ML	Same as Shaft 7 (but with 64 total RF)	8	2.8	50%	50%
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)**	24.76	8.59	155%	156%
6	ML	Main Linac Total Load x No fo RF at this shaft (128) divided by total no of ML RF (624)	16	5.5	100%	100%
8	RTML	Half of RTML total load	6	1.2	38%	22%
12	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)	2.06	0.307	13%	6%
14	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)	2.06	0.307	13%	6%
18	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)	2.06	0.307	13%	6%
16	e+ DR	e+ DR load total divided by 4 (except for chilled water only the alcoves are considered)	2.06	0.307	13%	6%
* doesn't include heat of compression, ** Doesn't include chw for ventilation/dehumidication			175	41		



WATER PLANT LOCATION

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mulitplier of WATER plant cost
estimate based on plant#7

Aug 28 2

LOCATION SHAFT	AREA SERVED	PROCESS MULITPLIER	CHW COST	A1 e- source	A2 e+ source	A3 DR	A4 RTML	A5 Main Linac	A6 BDS	E Exp'mt	G Gen'l &
17	Elec DampRing	10%	4%			100%					
15	Elec DampRing	10%	4%			100%					
19	Elec DampRing	10%	4%			100%					
13	Elec DampRing	10%	4%			100%					
11	RTML	38%	22%				100%				
9	e-Source	12%	12%	100%							
7	Main Linac	100%	100%					100%			
5	Main Linac & e+source	143%	144%		34%			66%			
3	Main Linac	50%	50%					100%			
A	BDS & Main Dumps	158%	24%						100%		
B	BDS & Main Dumps	158%	24%						100%		
2	Main Linac	50%	50%					100%			
4	Main Linac &source	155%	156%	7.51%	31.91%			60.58%			
6	Main Linac	100%	100%					100%			
8	RTML	38%	22%				100%				
12	Positron DampRing	13%	6%			100%					
14	Positron DampRing	13%	6%			100%					
18	Positron DampRing	13%	6%			100%					
16	Positron DampRing	13%	6%			100%					

SEP 7 2006 DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT DRAFT (estimates need to be checked) eh

REDUCTION OF CFS MECHANICAL COST (Process Cooling WBS Shown) **(Values in $K)**

	Bold red indicate Items for Marc	TOTAL	M LINAC	BDS	Started: Aug 10 2006	
	Items	% reduction based on Initial Cost/Jul 14 numbers	% reduction based on Initial Cost/Jul 14 numbers	reduction based on Initial Cost/Jul 14	Impact/ Notes	BHP IMPACT
A	Initial Cost (July 14 2006)				Based on 296 MW thermal Load (placeholders)	
B	Check Estimate	*later*	*later*	*later*	*later*	
C	Updated Thermal Load, added missing items, Corrected errors & **reduced Skid to 2X (1 skid to 2 RF),** = Suggest to use this as **NEW BASELINE**	23%	3%	62%	Based on current Thermal load 222 MW (Aug 30 2006) - Note that these numbers are preliminary according to Area System/Contact. BDS load down from ~70MW to ~17MW (preliminary) Numbers from Magnet Group are not considered. It doesn't include the Sources and BDS changes Still waiting for more Vendors info on various Skid sizing. Currently use $90K per skid but doesn't include quantity discount.	

The % in the following are approximate and are %reduction as compared to the Jul 14 estimate.

1	**Make All Chiller Aircooled** (1 Skid /2 RF; 20 Delta T on Process; Updated Load per Item C)	25%	6%	63%	Remove Cooling Tower & Pump for the Chillers. Chillers can be located outside the bldg (reduced bldg cost not included). KW electrical capacity increase by ~10 to ~15% There will be no free cooling during winter. Operating cost increase.	+ +
2	**Reduce LCW Skid to 1 Skid to 4 RF at 20 delta**	29%	10%	65%	Still waiting for more Vendors info on various Skid sizing. Currently use $90K per skid but doesn't include quantity discount.	TBD
3	**Increase Process water delta T to 40 F (with 1 skid 2 RF)**	**32%** about 40% of this is due to load reduction and correction	14%	67%	Impact of 40 delta F on RF water load not included (by???)/ Piping scheme to get 40F delta in Rf components not considered 40 delta F is also acceptable in Magnet load (Meeting with magnet Aug 22 2006) Note that BDS Water Dump has 54F delta. Since cost is scaled from Shaft 7, this cost reduction may not be reflected (see add; item below) Impact on BHP.....TBD	TBD
4	**Increase Process water delta T to 40 F (with 1 skid 4 RF)**	**38%** about 40% of this is due to load reduction and correction	21%	70%	Impact of 40 delta F on RF water load not included (by???)/ Piping scheme to get 40F delta in Rf components not considered 40 delta F is also acceptable in Magnet load (Meeting with magnet Aug 22 2006) Note that BDS Water Dump has 54F delta. Since cost is scaled from Shaft 7, this cost reduction may not be reflected (see add; item below) Impact on BHP.....TBD	TBD

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5	**Remove Chilled Water** ** (*Water Cooled Racks will have dedicated chiller- preliminary concept based on Liebert XDF. Cost for this is assumed as included with other group*)	**45%** about 40% of this is due to load reduction and correction	36%	67%	Warm Temperature / Temperature stability could be an issue Main Linac (Adolphsen email Sep 5 2006) require 29C (84F) air temperature. Need Chilled Fancoil for this.. Chilled Water system Is still needed for BDS (requirement) A CFD analysis of the space will be pursued to provide the variation of temperature across the tunnel to see if acceptable. OSHA Sec 3 Chap 4 Heat Stress at 95F at 55dewpoint equatte to WGBT of 77F adequate for continuous heavy work. May require chilled water fancoils to maintain to this. Based on Libert cost (info sent to HLRF Sep 1) for rack with chlr,. Assume cost included with other group for this scheme. NOTE That cost reduction in fancoil cost is not included. Impact of BHP……TBD	–
6	**Reduce CHW** (Variation of Item 5 except CFS will have cost for dedicated CHLR, skids & piping to ML racks, and no fancoils for other equipment heat load to air) NOTE: We couldn't find a small water to water dedicated chiller at this point.	**32%** about 40% of this is due to load reduction and correction	16%		Warm Temperature / Temperature stability could be an issue Main Linac (Adolphsen email Sep 5 2006) require 29C (84F) air temperature. Need Chilled Fancoil for this.. Chilled Water system Is still needed for BDS (requirement) A CFD analysis of the space will be pursued to provide the variation of temperature across the tunnel to see if acceptable. OSHA Sec 3 Chap 4 Heat Stress at 95F at 55dewpoint equatte to WGBT of 77F adequate for continuous heavy work. May require chilled water fancoils to maintain to this. Large footprint for the dedicated rack chiller. Could be space issue… Dedicated Chiller Skid for each water cooled RF Racks (1 per RF), wag at $25installed cost based on phone with Vendor (Ecobay) but to be checked later, and based on aircooled (Libert) email at $15K + install (but this is only aircooled). 10 Ton Ecobay budget of $40K not used for now. NOTE That cost reduction in fancoil cost is not included. Impact of BHP……TBD	TBD
7	**Reduce CHW** (Variation of Item 5 except provide chilled water only on smaller area in the service tunnel for worker to work)					
8	Eliminate HX and Pump and Cavern				higher water pressure in the tunnel piping. Water Skid should be sized to accept higher pressure (Dan Lacedra of Bornquist suggested 15% increase in cost of the skid for this) Savings in Cavern space for equipment (not considered atthis point) Glycol in the tunnel piping, issue or no???	
9	One Large LCW Distribution from the Cavern				No data for large 14" to 18" ss pipe. (discussed with two vendors- Aug 22 2006) Large piping main at Stainless and Cavern pump at Stainless will be very expensive	
10	**(1 Skid to 8 RF)**					
11	Provide one plant for BDS					
12	Separate Estimate for BDS Plant at 54delta F					
13	Various HX approach temperatures vs HX cost					

CUB equipment 8/15/2006 eh

				Variation (What if LCW only)
Tower Water				
	HP	KW -installed		
CT1 (980 Ton each)	60	44.76		44.76
CT2	60	44.76		44.76
CT3	60	44.76		44.76
CT4	60	44.76		44.76
CT5	60	44.76		
CT6	60	44.76		
CT7	60	0		
TWP1	300	223.8		223.8
TWP2	300	223.8		
TWP3	300	0		
TWP4	0	0		0
TWP5	0	0		0
TWP6	200	149.2		149.2
TWP7	200	0		
TWP8	150	111.9		
TWP9	150	111.9		
TWP10	150	0		
Sandfilter Pump	minor	0		
Chilled Water				
	Tons			
CH1	750	*487.5*		
CH2	1400	*910*		
CH3	750	*487.5*		
CH4	1400	*0*		
CH5	750	*487.5*		
	HP			
CP1	40	29.84		
CP2	40	29.84		
CP3	40	0		
CP4	75	55.95		
CP5	75	55.95		
CP6	250	186.5		
CP7	250	186.5		
CP7A	30	22.38		
CP8	30	22.38		
CP9	40	29.84		
CP10	300	223.8		
CP11	300	0		
CP12	30	0		
CP13	30	0		
CP14		0		
		0		
LP1	200	149.2		149.2
LP2	200	149.2		149.2
LP3	200	0		0
LP4	200	149.2		149.2
LP5	200	0		0
LP6	125	93.25		93.25
LP7	125	93.25		93.25
LP8	125	0		0
LP9		0		0
LP10		0		0
LP11		0		0
LP12		0		0
LP13	40	0		0
LP14	40	0		0
		0		0
LCWP1	30	22.38		22.38
LCWP2	30	22.38		22.38
LCWP3	30	0		0
DP1	15	11.19		0
LinacP	50	37.3		0
		5031.99	KW	1230.9
LOADS (equipment rating)				
ChW Load	Tons			
CH1	750	2636		
CH2	1400	4921		
CH3	750	2636		
CH4	1400	0		
CH5	750	2636		
LCW HX	Tons			
HX1	1422.917	5002		5002
HX2				
HX3				
HX8	917	3222		3222
HX9				
HX7				
		21053	**KW**	**8224** KW
		0.24	**W/W**	**0.15** W/W
Portion of CHW		**61%**		**0%**

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portion of LCW	**39%**	**100%**

Accelerator equipment

8/15/2006

Main Injector	$HP_{Installed}$	$Watts_{Installed}$	$Watts_{Cooling\ Loads}$
MI-10 S01	100	74.6	600
MI-10 S02	100	74.6	600
MI-10 S03	100	74.6	600
MI-10 S04	50	37.3	600
MI-20 S01	100	74.6	600
MI-20 S02	100	74.6	600
MI-20 S03	100	74.6	600
MI-20 S04	50	37.3	600
MI-30 S01	100	74.6	600
MI-30 S02	100	74.6	600
MI-30 S03	100	74.6	600
MI-30 S04	50	37.3	600
MI-40 S01	100	74.6	600
MI-40 S02	100	74.6	600
MI-40 S03	100	74.6	600
MI-40 S04	50	37.3	600
MI-50 S01	100	74.6	600
MI-50 S02	100	74.6	600
MI-50 S03	100	74.6	600
MI-50 S04	50	37.3	600
MI-50 S01	100	74.6	600
MI-50 S02	100	74.6	600
MI-50 S03	100	74.6	600
MI-50 S04	50	37.3	600
MI-52 S01	150	111.9	267
MI-52 S02	150	111.9	267
MI-52 S03	50	37.3	267
MI-60 S01	100	74.6	600
MI-60 S02	100	74.6	600
MI-60 S03	1400	1044.4	600
MI-60 S04	50	37.3	600
MI-60 RF S01	100	74.6	500
MI-60 RF S02	100	74.6	500
MI-60 RF S03	100	74.6	500
MI-60 RF S06	150	111.9	111.9
MI-60 Cavity S01	100	74.6	150
Total (KW)		**3468.9**	**19362.9**

Tevetron	$HP_{Installed}$	$Watts_{Installed}$	$Watts_{Cooling\ Loads}$
TEV A-1	50	37.3	350
TEV A-2	50	37.3	350
TEV A-3	50	37.3	350
TEV A-4	50	37.3	350
TEV Pond A-5	75	55.95	0
TEV B-1	50	37.3	250
TEV B-2	50	37.3	250
TEV B-3	50	37.3	250
TEV B-4	50	37.3	250
TEV Pond B-5	75	55.95	0
TEV C-1	50	37.3	400
TEV C-2	50	37.3	400
TEV C-3	50	37.3	400
TEV C-4	50	37.3	400
TEV Pond C-5	75	55.95	0
TEV D-1	50	37.3	160
TEV D-2	50	37.3	160
TEV D-3	50	37.3	160
TEV D-4	50	37.3	160
TEV Pond D-5	75	55.95	0
TEV E-1	50	37.3	0
TEV E-2	50	37.3	215
TEV E-3	50	37.3	215
TEV E-4	50	37.3	215
TEV Pond E-5	75	55.95	215
TEV F-1	50	37.3	550
TEV F-2	50	37.3	550
TEV F-3	50	37.3	550
TEV F-4	50	37.3	550
TEV Pond F-5	75	55.95	0
Total (KW)		**1230.9**	**7700**

Watt per Watt Values

Main Injector **0.18 W/W**

Tevetron **0.16 W/W**

Note 1- TEV and MI calculations are based on a 7C average rise requirement.
Note 2 - Tevetron Heat Loads are shown as divided by four bldgs per sector, given by Bob B
Note 3 - Main Injector Heat Loads are shown as divided by four pumps per service buildings,

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Watt per Watt using BHP (Shaft 7) eh Sep 1 2006

Shaft 7 (operating only)	QTY	BHP	KW
Tower Pump-CHW	1	97	72
Chiller Pump-CHW	1	83	62
Cavern Pump-CHW	2	101	151
Chiller - 1575 Ton @ 0.575KW/Ton			905
Tower Fans -CHW	6	30	134
Tower Fans -CHW	6	15	67
Tower Spray-CHW	6	7.5	34
Rack Skid - CHW	32	5	119
Fancoil - CHW	256	1.5	286
Tower Pump-Process	2	141	210
Cavern Pump-Process	2	167	249
Tower Fans -process	12	30	269
Tower Fans -process	12	15	134
Tower Spray-process	12	7.5	67
LCW Skid	64	15	716
			3476.462 KW

Thermal Load at Shaft 7 (See Shigeki Spreadsheet)			
LCW	125	128	16000
Air	40	128	5120
			21120 KW

Watt per Watt	0.165

ToTal Thermal MW	222	MW
Estimated MW cooling Equip	37	MW

Watt per Watt using HP (Shaft 7) eh Sep 1 2006

Shaft 7 (operating only)	QTY	BHP	KW
Tower Pump-CHW	1	125	93.25
Chiller Pump-CHW	1	100	74.6
Cavern Pump-CHW	2	125	186.5
Chiller - 1575 Ton @ 0.575KW/Ton			905
Tower Fans -CHW	6	30	134.28
Tower Fans -CHW	6	15	67.14
Tower Spray-CHW	6	7.5	33.57
Rack Skid - CHW	32	5	119.36
Fancoil - CHW	256	1.5	286.464
Tower Pump-Process	2	200	298.4
Cavern Pump-Process	2	200	298.4
Tower Fans -process	12	30	268.56
Tower Fans -process	12	15	134.28
Tower Spray-process	12	7.5	67.14
LCW Skid	64	20	954.88
			3921.824 KW

Thermal Load at Shaft 7 (See Shigeki Spreadsheet)			
LCW	125	128	16000
Air	40	128	5120
			21120 KW

Watt per Watt	0.186

ToTal Thermal MW	222	MW
Estimated MW cooling Equip	41	MW

SHAFT 7 LCW PLANT pumps estimate (Main Linac Only)

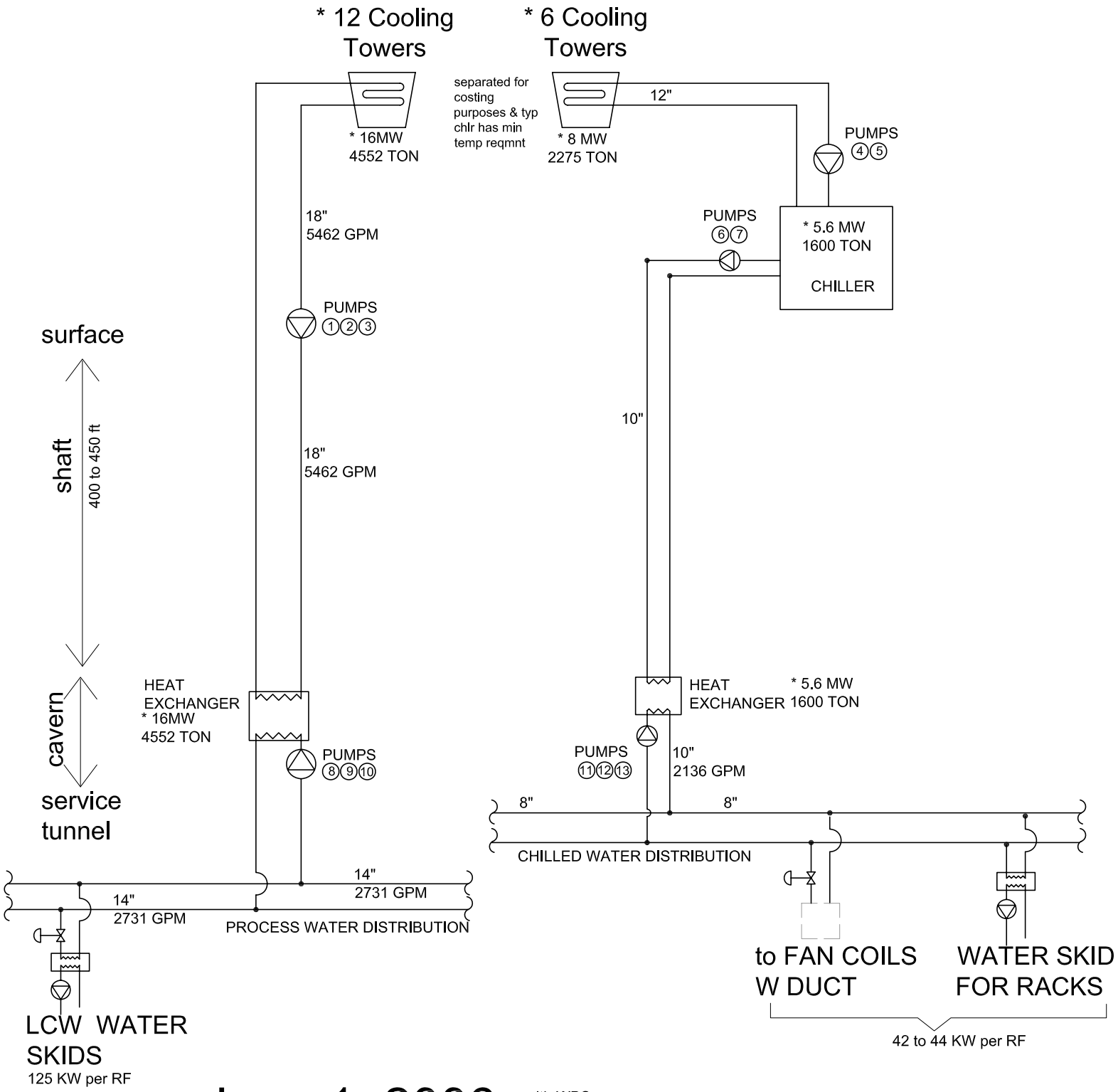
Aug 28 2006

	BASE: with chilled water to handle other air load	with chilled water to handle other air load	adjusted load (wag portion of load to air back to water)- No chw	adjusted load (wag portion of load to air back to water)- No chw	adjusted load (wag portion of load to air back to water)- No chw	adjusted load (wag portion of load to air back to water)- No chw	adjusted load (wag portion of load to air back to water)- No chw
LCW Load per RF (thermal KW) **	125	125	148	148	148	148	148
Delta T (delta F)	**20**	**20**	**26**	**26**	**30**	**40**	**40**
No of RF at Shaft 7 Plant	128	128	128	128	128	128	128
Flow per RF (gpm)	43	43	39	39	34	25	25
Total Flow for shaft 7 plant	5,462	5,462	4,975	4,975	4,312	3,234	3,234
LCW Plant for shaft 7 (MW)	16	16	19	19	19	19	19
Flow at Tunnel (gpm)	**2,731**	**2,731**	**2,487**	**2,487**	**2,156**	**1,617**	**1,617**
PROCESS PUMP FROM CAVERN TO SKID							
Piping at Tunnel							
Size along tunnel length	varies	varies	varies	varies	varies	varies	varies
Max Pipe Size (near base of shaft)	14"	12"	14"	12"	12"	10"	12"
% portion of this in tunnel piping	41%	28%	6%	38%	25%	42%	9%
Average Pressure Drop (ft / 100 ft)	0.51	1.711	0.73	0.76	0.8	0.703	0.64
Average Velocity (fps) - low-	4.22	6.5	4.73	4.8	4.74	4.3	4.1
Tunnel Piping Only Cost (**K**$)	$ 4,364	$ 3,211	$ 3,547	$ 3,595	$ 3,073	$ 1,840	$ 2,384
% reduction cost in tunnel piping only	N/A	26%	19%	18%	30%	58%	45%
(Main linac Process Cooling Cost)							
% reduction cost based on overall ML Process Cooling (incl engg)		**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
(Main linac Total CFS Cost)							
% reduction in cost based on overall ML CFS cost (incl engg)		**TBD**	**TBD**	**TBD**	**TBD**	**TBD**	**TBD**
Length Tunnel Pipe (one leg) ft-supply& return (~5.1Km)	16728	16728	16728	16728	16728	16728	16728
Pressure Drop Piping Only - ft	*85*	*286*	*122*	*127*	*134*	*118*	*107*
Overall % Reduction in cost based on Total Process Cool							
Main Piping from Tunnel to Cavern							
Size	18"	18"	18"	18"	16"	14"	14"
Average Pressure Drop (ft / 100 ft)	0.93	0.93	0.77	0.77	1.06	1.08	1.08
Pipe velocity (fps)	7.84	7.84	7.14	7.14	7.83	7.25	7.25
Length Tunnel Pipe (supply&return) **wag**	150	150	150	150	150	150	150
Pressure Drop Main Piping -tower to Cavern	*1.40*	*1.40*	*1.16*	*1.16*	*1.59*	*1.62*	*1.62*
Miscellaenaous							
Allowance for Heat Exchngr pressure drop (Cavern) - ft	23	23	23	23	23	23	23
Allowance for Heat Exchngr pressure drop (LCW Skid) - ft	23	23	23	23	23	23	23
Allowance for Control Valves- ft - **wag**	30	30	30	30	30	30	30
Total Drop for Miscellaneous	*76*	*76*	*76*	*76*	*76*	*76*	*76*
Subtotal Press Drop	163	364	200	204	211	195	185
Allowance for fittings and safety factor 15% - **wag**	24	55	30	31	32	29	28
Total (ft)	**187**	**418**	**230**	**235**	**243**	**225**	**212**
Total (psi)	81	181	99	102	105	97	92
Actual Pump Selection- (2 pump runng, 1 stdby) (see attached selection)							
Bhp @ Design Point each pump -flow at row9 & head @ row35	**167**		**185**	**190**	**176**	**120**	**115**
HP each pump (installed) (non-overloading)	**200**		**225**	**225**	**225**	**150**	**150**
Quantity Pump Running	2		2	2	2	2	2
Quantity Pump Stdby	1		1	1	1	1	1

44	**PROCESS PUMP -TOWER TO CAVERN**							
45	**Main Piping from Tunnel to Cavern**							
46	Size	18"	18"	18"	18"	16"	14"	14"
47	Average Pressure Drop (ft / 100 ft)	0.93	0.93	0.77	0.77	1.06	1.08	1.08
48	Pipe velocity (fps)	7.84	7.84	7.14	7.14	7.83	7.25	7.25
49	Length Pipe (supply&return) cavern to tower -**wag**	1800	1800	1800	1800	1800	1800	1800
50	Pressure Drop Tunnel Main Piping -tunnel to Cavern	*16.74*	*16.74*	*13.86*	*13.86*	*19.08*	*19.44*	*19.44*
51								
52	**Miscellaneous**							
53	Allowance for Heat Exchngr pressure drop (Cavern) - ft	23	23	23	23	23	23	23
54	Allowance for Cooling Tower pressure drop (30 psi) - ft	69.3	69.3	69.3	69.3	69.3	69.3	69.3
55	Allowance for Control Valves- ft - **wag**	30	30	30	30	30	30	30
56	Total Drop for Miscellaneous	*122.3*	*122.3*	*122.3*	*122.3*	*122.3*	*122.3*	*122.3*
57								
58	**Subtotal Press Drop**	139	139	136	136	141	142	142
59	Allowance for fittings and safety factor 15% - **wag**	21	21	20	20	21	21	21
60	Total (ft)	**160**	**160**	**157**	**157**	**163**	**163**	**163**
61	Total (psi)	69	69	68	68	70	71	71
62								
63								
64	Actual Pump Selection- (2 pump runng, 1 stdby) (see attached selection)							
65	Bhp @ Design Point each pump -flow at row9 & head @ row60	**141**	**141**	**128**	**128**	**117**	**87**	**87**
66	HP each pump (installed)	**175**	**175**	**150**	**150**	**150**	**100**	**100**
67	Quantity Pump Running	2	2	2	2	2	2	2
68	Quantity Pump Stdby	1	1	1	1	1	1	1

** tower hp will change ** some load to air transferred to LCW (wag)*

BASIS: WATER SURFACE PLANT AT SHAFT 7



June 1, 2006 with WBS numbers