

ILC CFS Baseline Technical Review

CONVENTIONAL MECHANICAL *RDR to TDR*

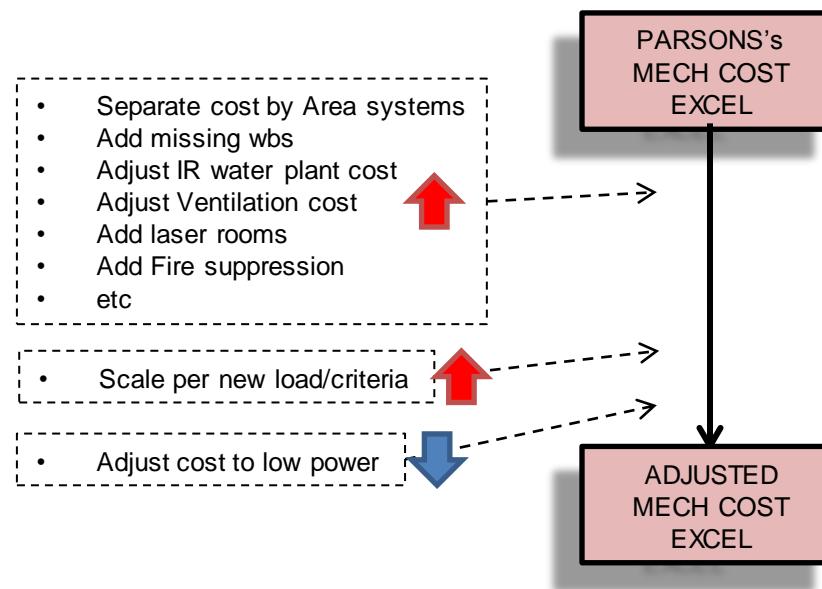
Emil Huedem
Lee Hammond

March 22, 2012

This presentation contains costs and should not be posted or distributed except by those who can.

Conventional Mechanical System Design

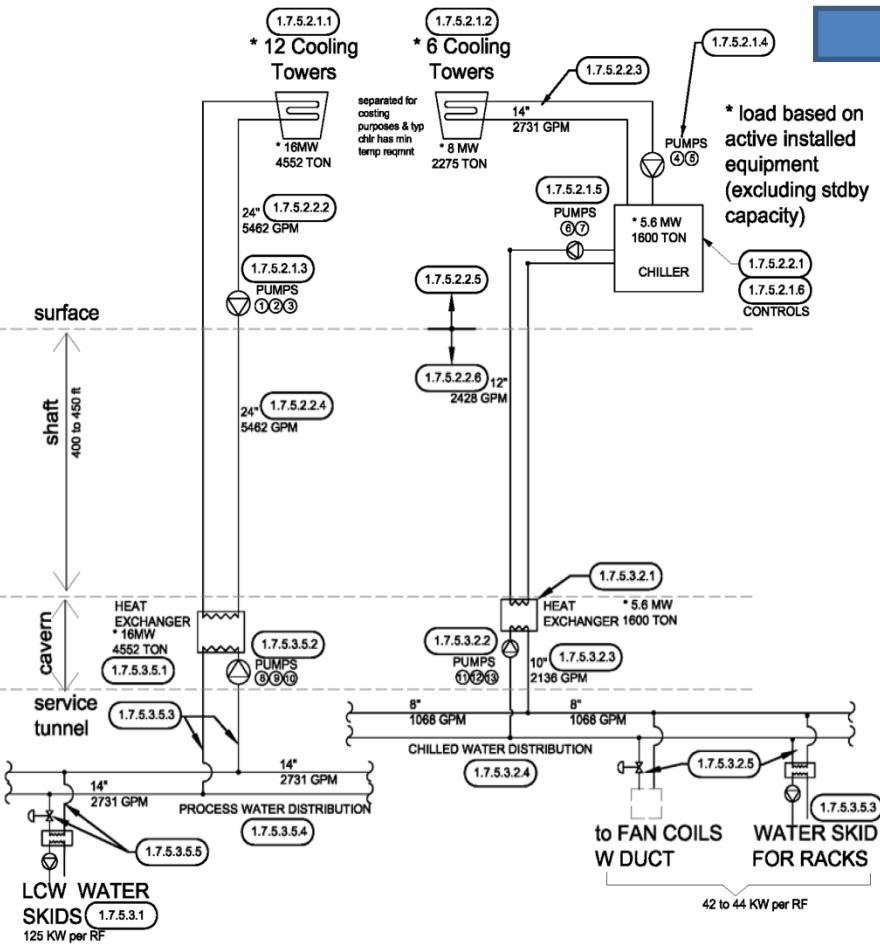
- Technical loads came from various area system, latest criteria/load tables are uploaded to EDMS
- Used consultant for concept design & independent costing of specific wbs based on previous criteria (before Jul 2011)
- Bottoms up estimate for each plant, instead of scaling of shaft-7 used in RDR
- Mid-2011 base year & used full power criteria (pre-July2011)
- We'll adjust Parsons base cost to bring it to baseline



Evolution of Process Cooling System

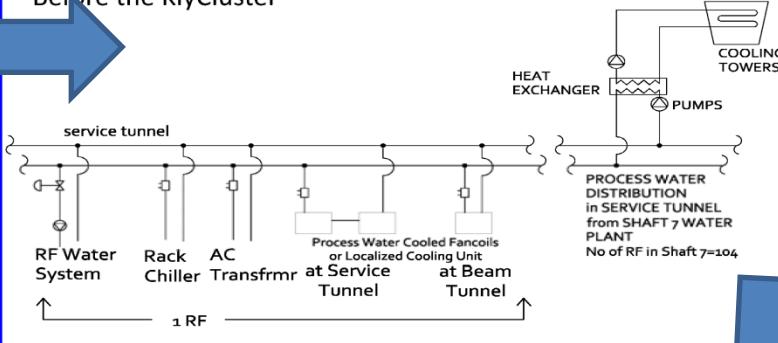
DRAFT DEC 7, 2010

RDR-JUN 2006 : Plant at Shaft 7 (used as basis)

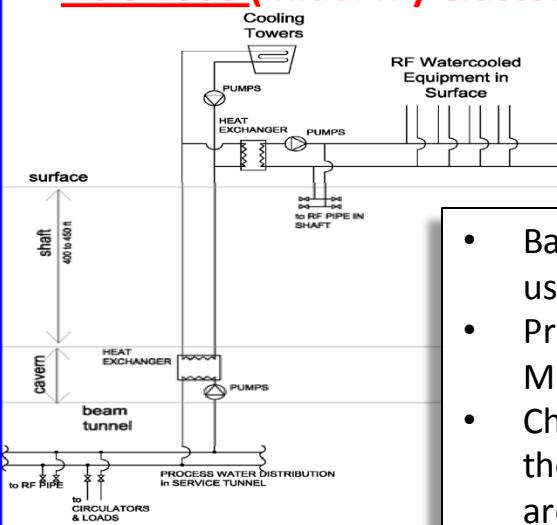


PostRDR- JUL 2008 (VE costing exercise)

Before the KlyCluster



AUG 2008 (initial Kly Cluster KCS)



- Basic concept used in KCS
- Process Water in ML/RTML
- Chilled water in the rest of the area

POST RDR

DESCRIPTIONS & "color" legend (DRAFT Dec 18 2007)		With a detailed cost analysis
High cost potential could be lower if some assumptions are made	Yellow	
Cost (red) may result to savings will be evaluated? (potential cost savings TBA)	Red	
Cost (green) may result to savings will be evaluated? (potential cost savings TBA)	Green	
Cost (blue) - less likely, not sure	Blue	
Provide one high efficiency oxygen power / cooling plant on site and distribute power and 33 degree F chilled water throughout the facility, remove the power generation and chilling cost from the project cost	Green	
Eliminate one piping system by using process water as primary rejection for the chilled water system w/ tank, (integrated heat pump on tanks and elevations chillers for racks)	Green	
Decentralize power systems by using process water as primary rejection for chilled water system w/ tank, (integrated heat pump on tanks and elevations chillers for racks)	Green	
Decrease the delta T in Wtch 1, CW and 1000A or reduce temperature to 30 degrees Celsius (water side wft)	Green	
Add a chiller on the process water side wft	Green	
Lower the temperature in the tunnel to 65 or 70 degrees to increase operating efficiency, extend equipment life, and lower energy costs	Green	
Consider use of renewable energy source for use with oxygen system wft	Green	
Provide a cost analysis for reducing the overall cooling load by 5% and 10% wft	Green	
Centralize the cooling system	Green	
Provide distributed oxygen power / cryo. trailer to #2 & 3	Green	
Decentralize the 345 KV substation function w/ 18, 20, 28, & 38	Tracy	
Electrically engineer the distribution system to optimize and reduce cost wft	Tracy	
Provide connection to electrical utility system at all shafts (w/ 90)	Tracy	
Optimize substation spacing wft	Tracy	
Let the electrical utility construct substations and don't include that cost in the project construction cost wft	Tracy	
Centralize the HVAC and reconfigure air flow from the ends	Lee	
Pipe two chilled water coils in series, chilled water intake, size one for 30 degree delta T wft	Lee	
Provide one piping system by using process water as primary rejection for chilled water system w/ tank, (integrated heat pump on tanks and elevations chillers for racks)	Red	
Water current temperature (T) 100 degrees at end (lower power O&G requirement ref?)	Red	
Provide air conditioned suits for personnel working in tunnel and let the temp go higher than OSHA requirements	Kenn	
Consider overrating electrical cables and transformers to reduce heat	Kenn	
Reduce the RF noise for more efficient process water flow	Kenn	
Modify top shaft HVAC to only process make up air, add blowers down shaft for recirculation	Lee	
Reduce lighting level to green limits	Lee	
Replace water pressure drop across components, minimize head pressure	Lee	
Examine possibility of going to 2 condenser water loops instead of 3 as presently planned	Shel	
Centralized cooling system to central main station w/ 1000A wft (chilled water central for your personal needs)	Tracy	
Allow thermal bypass of other components (RF, CTFW, 1000A, vacuum lines, support PTFE) who do not require constant wft	Lee	
Consider replacing the fan coil units with a chilled water beam (radiant cooling)	Kenn	
Put the water piping in the concrete slab, eliminate pipe supports	Tracy	
Use water cooled wavyguide in the accelerator tunnel in lieu of air cooling	Lee	
Provide passive convection tunnel using cooling shafts during colder months	Lee	
Provide multiple modes of operation dependent on outdoor temperatures	Lee	
Develop loads that do not require low conductively wft	Publack	
Use the in-situ pipe insulation system for cooling the wavyguide (fire coated gas shield the wavyguide)	Lee	
Push the power source for selected loads when not being used	Yann	
Use pressure regulators to control the hydrostatic pressure in the collectors	Jean	
Define the maximum hydrostatic pressure for the collectors	Mike	
Consider expandability of systems - modular vs centralized	Tracy	
Reassess the loss changeout or maintenance power supplies	Mike	
Plan for a 4 month downtime during the summer	Rick	
Utilize the operation of the system to 72 degree wet bulb	Rick	
Use CO2 based monitoring and limit the intake of outside air to what is necessary to maintain a safe environment	Lee	
Use a dehumidifier to dehumidify ventilation air	Lee	
Evaluate each load individually to determine requirements	Mike	
Detailed power budget for the relay racks (480 W / RF = 10% of power supplies)	Mike	
Provide power supply that will work with excess wft if necessary (quasi-militaryized)	Kenn	
Use on site ponds for make up water		
Consider using cooling ponds in lieu of cooling towers		
Give or sell them chiller to neighboring communities		
Provide the minimum required quantity of LCW wft		
Use vapor phase cooling on the collectors to generate electricity from excess energy		
Use the lowest KVA transformer to reduce heat load		
Consider use of geothermal cooling		
Use the Fox river for once thru primary cooling, eliminate the cooling towers		
Use modular systems for all equipment		
Decentralize Rack, Solid and replace with Juniper pump	Tom/Kenn	
Eliminate one piping system by using chilled water only as primary rejection, eliminate process water distribution	Tom/Kenn	

- About 50+ list from V.E. in Nov 2007, List from value engineering sessions in Nov 2007. Some appear to have real good cost reduction potentials.

- Project focus on “first-cost” reduction

- Talks located in

<http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=2328>

- Description of each list, but no detailed evaluation

- Specific items selected by project to be evaluated in 2008

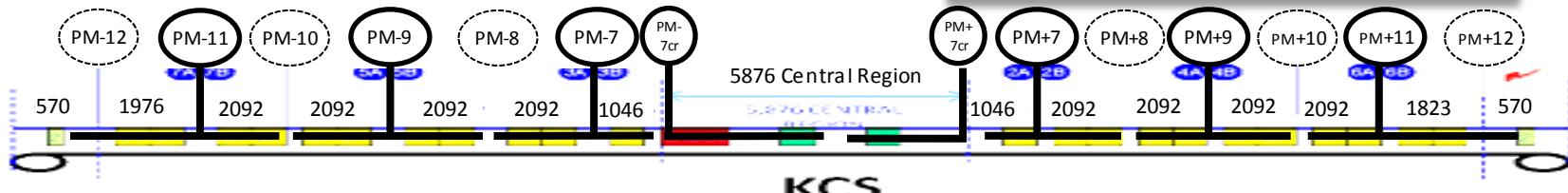
- **Elimination of centralized chilled in ML**
- Higher RF water delta T
- **Warmer tunnel temperature during operation and local cooling during maintenance**
- Other pipe materials

- **discussions during Parsons design effort**

- **Centralized LCW vs process wtr/skid**
- **Tunnel booster pump footprint=2/rf**
- **(stacking of loads) Surface RF High delta T 28 Fdt vs 15F = not much cost savng**
- **Surface RF ventilate or part of rack**
- **DR chilled water or not**

PROCESS WATER PLANT LOCATIONS & LOADS-KCS

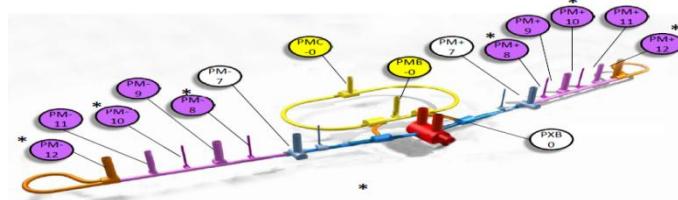
USED IN PARSON's DESIGN



KCS

(sample load distribution) *EXCLUDING non-technical components

New Shaft Nos	PM-12	PM-11	PM-10	PM-9	PM-8	PM-7	PMC-0	PMB-0	PXB-0	PXB-0	PM+7	PM+8	PM+9	PM+10	PM+11	PM+12	TOTAL MW (cooling)*	
Old Shaft Nos	Shaft 11	Shaft 7	Shaft 14	Shaft 5	Shaft 15	Shaft 3	Shaft 13	Shaft 12	Shaft 1.1	Shaft 1.2	Shaft 2	Shaft 16	Shaft 4	Shaft 17	Shaft 6	Shaft 10		
						(central region)				near this shaft	(central region)							
	2.1	21.0	4.85	17.3	4.85	16.54	11.9	14.5	2.8	2.3	36	9.9	16.54	4.85	17.3	4.85	210	
RTML		45% rtml 3.87					5% 0.43				5% 0.43				45% rtml 3.87		8.61	
ML(surface)	28 RF 2.12	64 RF 4.85	64 RF 4.85	64 RF 4.85	64 RF 4.85	64 RF 4.85						64RF 4.85	64RF 4.85	64RF 4.85	64 RF 4.85	64 RF 4.85	24 RF 1.82	79.59
ML(tunnel)**		105 RF 4.91		108 RF 5.04		81 RF 3.74						81 RF 3.74		108 RF 5.04		101 RF 4.73		
e+						100% 6.22											6.22	
e-											100% 4.3						4.30	
BDS						50% 5.20					50% 5.20						10.4	
DR							85% 11.97	15% 2.84									14.81	
Dumps										36							36.00	
CRYO (surface)		7.37		7.37		7.96	2.52	0	1.730			7.96		7.37		7.37	49.63	
IR									0.576								0.576	
** includes 0.914 KW nc magnet over 5 plants																	210	
* excluding conventional non-technical components (By Parsons)																		

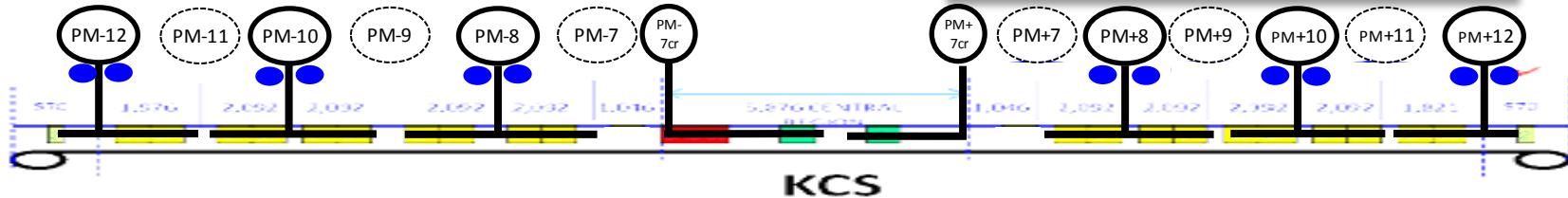


E. Huedem MAR 22 2012

DRAFT
7/19/2011
E. Huedem

PROCESS WATER PLANT LOCATIONS & LOADS-KCS

CURRENT CHANGES



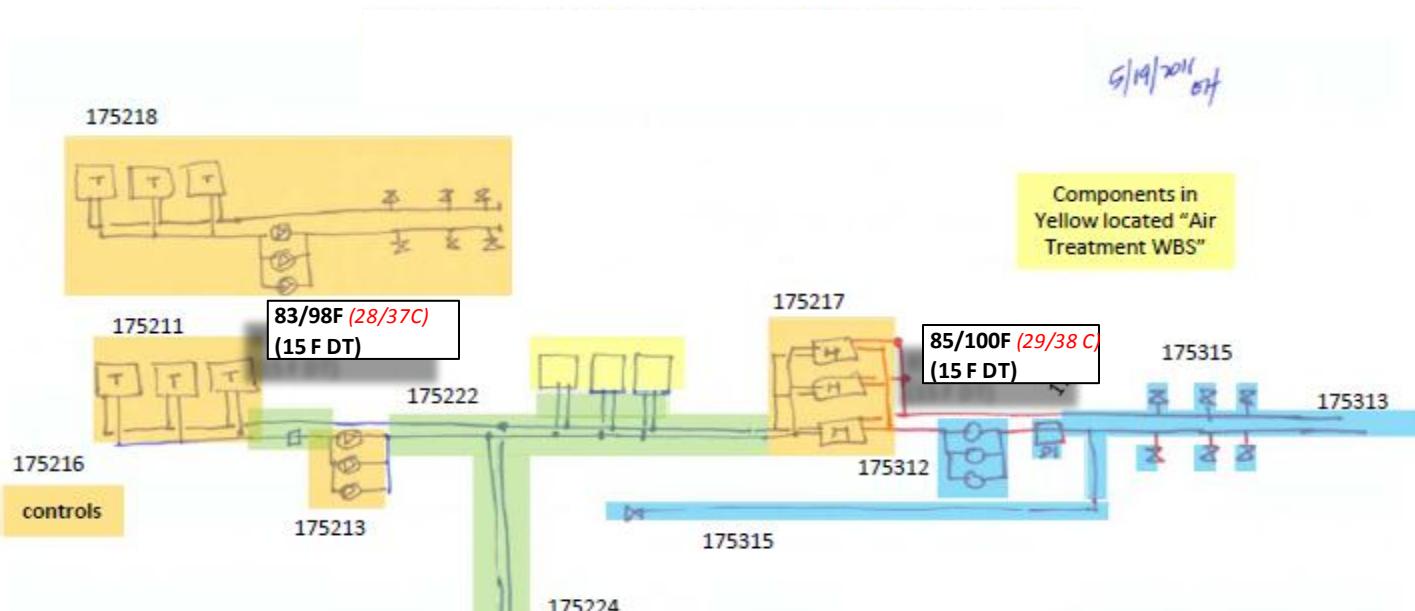
DRAFT Process Water Plants (KCS) Full power

MARCH 14, 2012

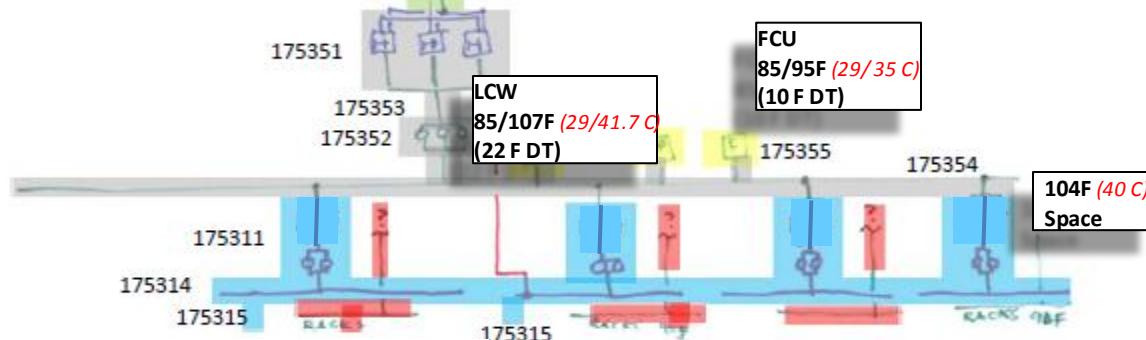
(sample load distribution) *EXCLUDING non-technical components

New Shaft Nos	PM-12	PM-11	PM-10	PM-9	PM-8	PM-7	PMC-0	PMB-0	PXB-0	PXB-0	PM+7	PM+8	PM+9	PM+10	PM+11	PM+12	TOTAL MW (cooling)*		
Old Shaft Nos	Shaft 11	Shaft 7	Shaft 14	Shaft 5	Shaft 15	Shaft 3	Shaft 13	Shaft 12	Shaft 1.1	Shaft 1.2	Shaft 2	Shaft 16	Shaft 4	Shaft 17	Shaft 6	Shaft 10			
						feed CR				near IR	feed CR								
	15.72	7.47	16.89	4.69	17.44	2.20	11.79	14.50	5.23	2.31	22.0	9.63	2.35	17.36	4.39	16.85	7.47	15.72 194	
RTML		48% rtml 2.78					2% 0.12					2% 0.12				48% rtml 2.78		5.79	
ML(surface)	62 RF 4.69	62 RF 4.69	62 RF 4.69	62 RF 4.69	62 RF 4.69	29 RF 2.20						31RF 2.35	58RF 4.39	58RF 4.39	62 RF 4.69	62 RF 4.69	62 RF 4.69	77.63	
ML(tunnel)**	78 RF 3.66		104 RF 4.83		103 RF 4.79							108 RF 5.01		103 RF 4.79		78 RF 3.66			
e+							100% 6.46											6.46	
e-												100% 4.3							4.30
BDS							50% 5.21					50% 5.21							10.43
DR								~70% 11.98	~30% 5.23										17.21
Dumps										22									22.00
CRYO (surface)	7.37		7.37		7.96		2.52	0	1.730			7.96		7.37		7.37		49.63	
IR	0								0.576									0.576	
** includes 0.914 KW nc magnet over 5 plants										* excluding conventional non-technical components							194		

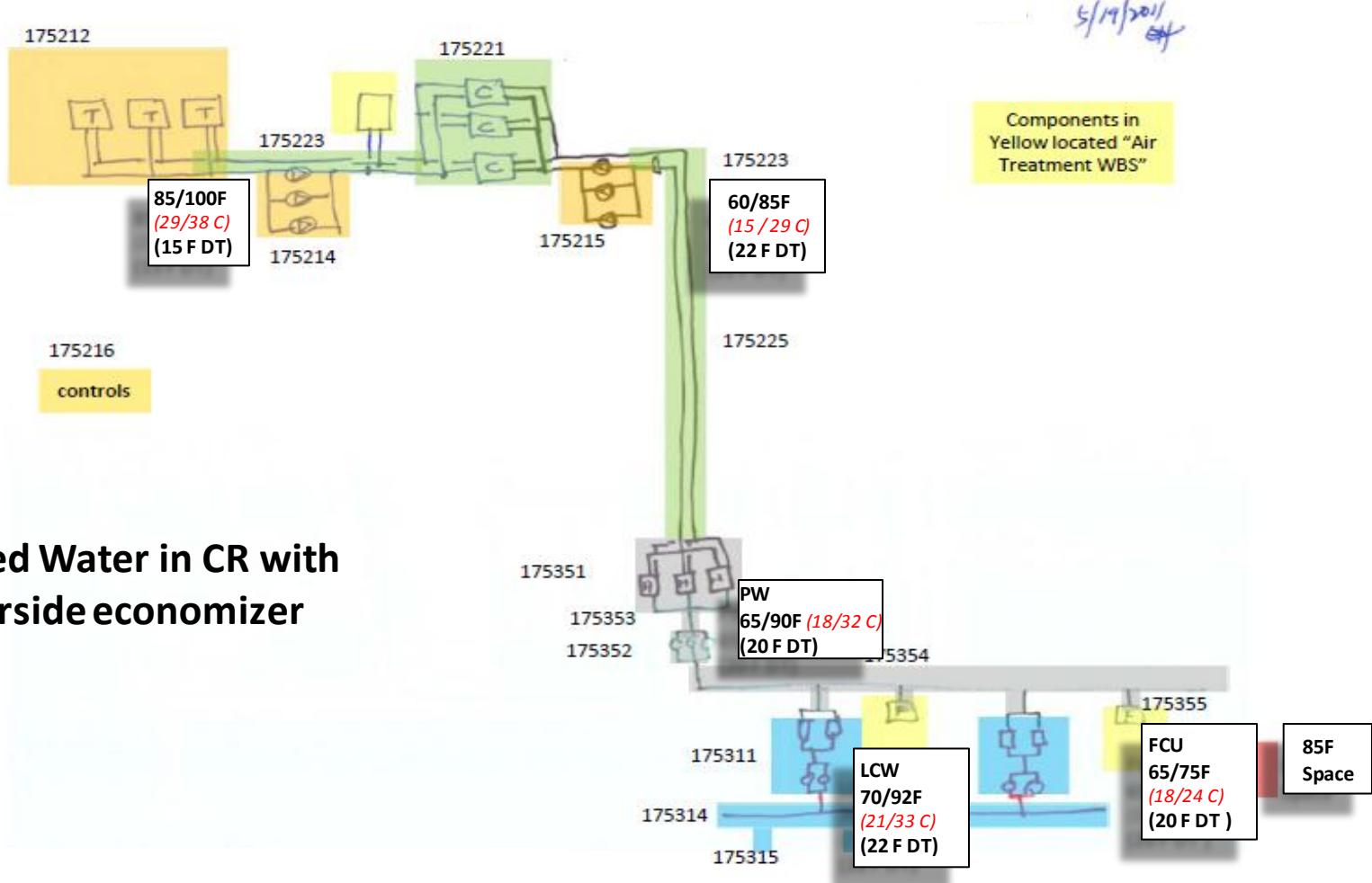
ML-KCS Process water System (simplified)



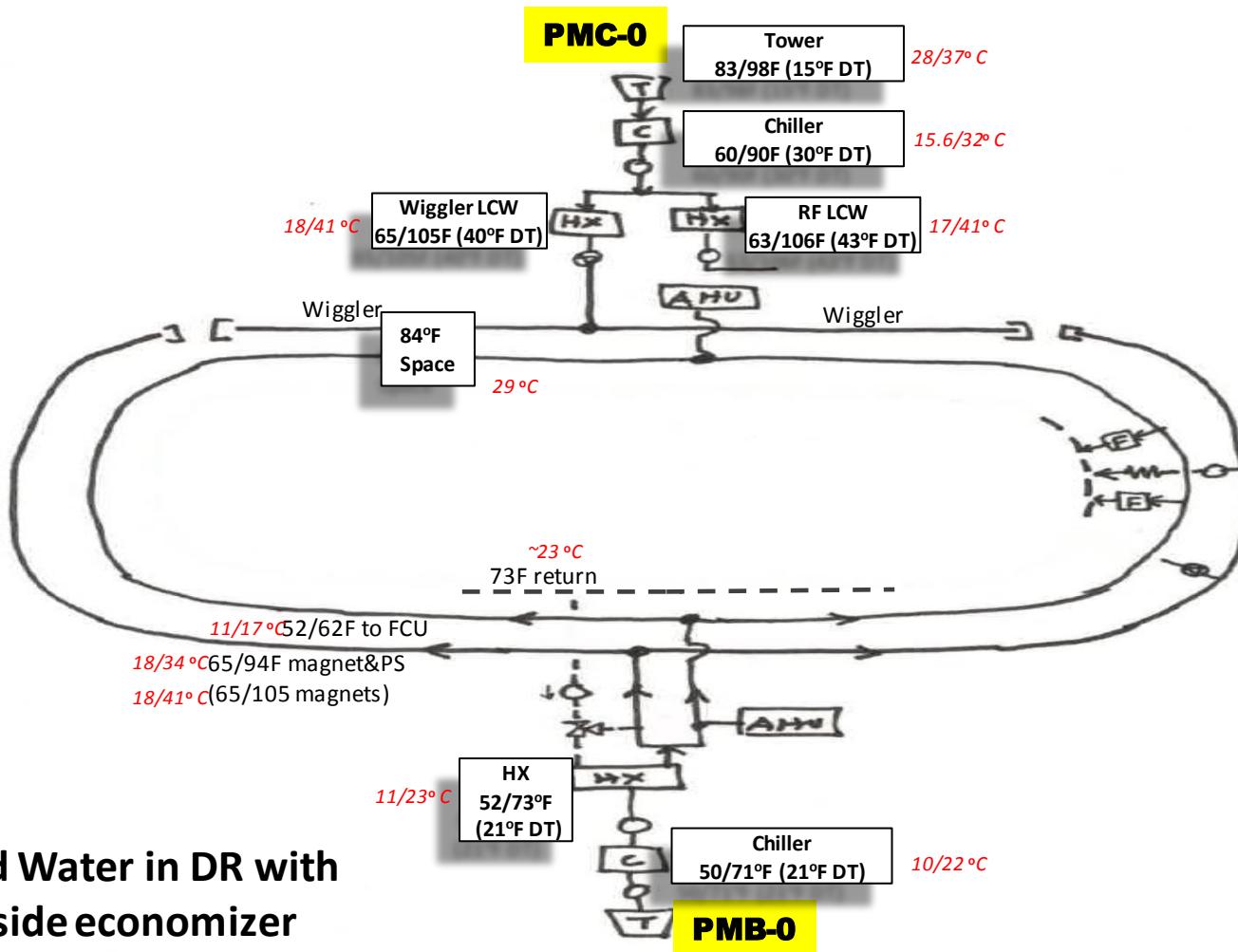
Process Water in ML/rhtml



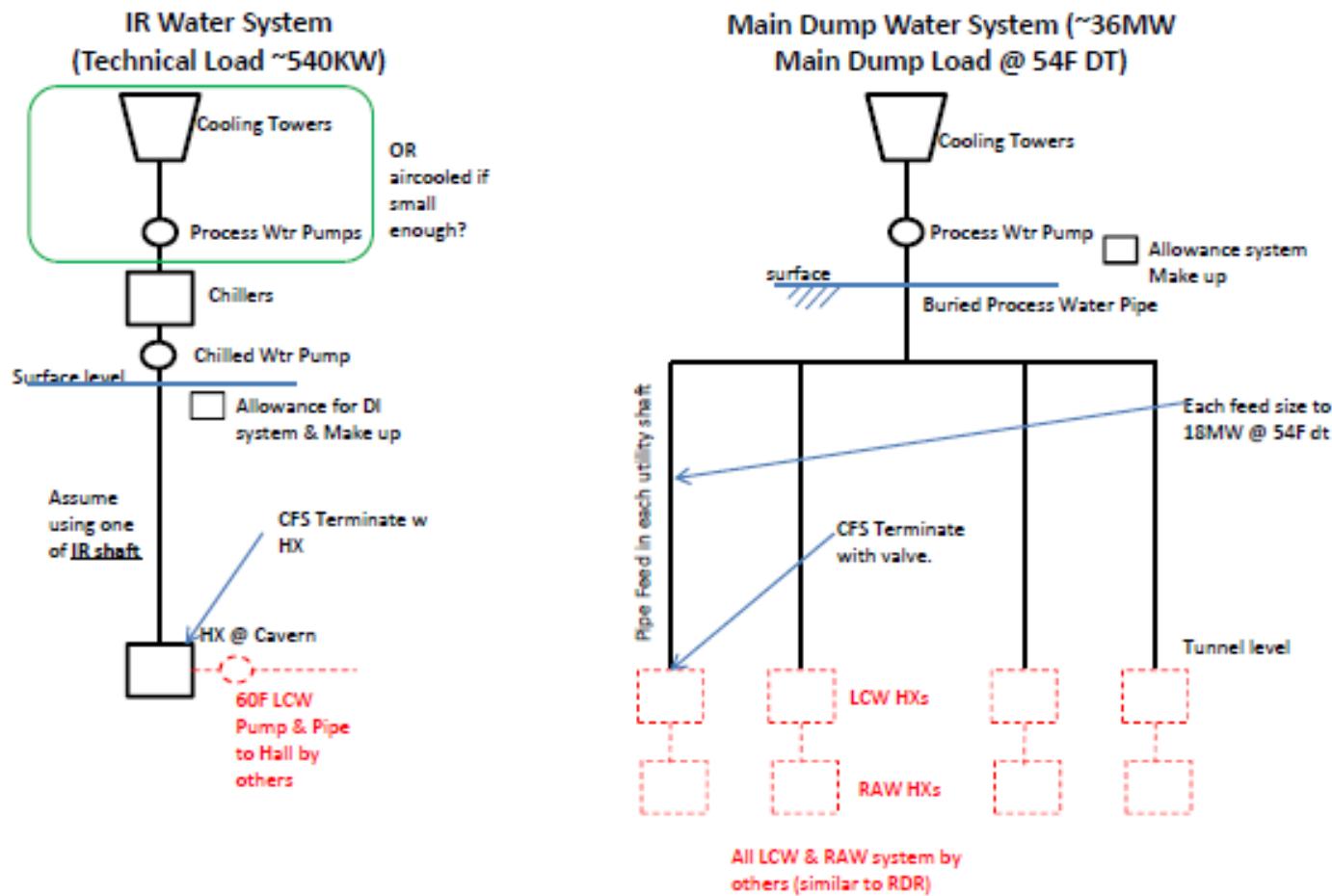
Central Region Process water System (simplified)



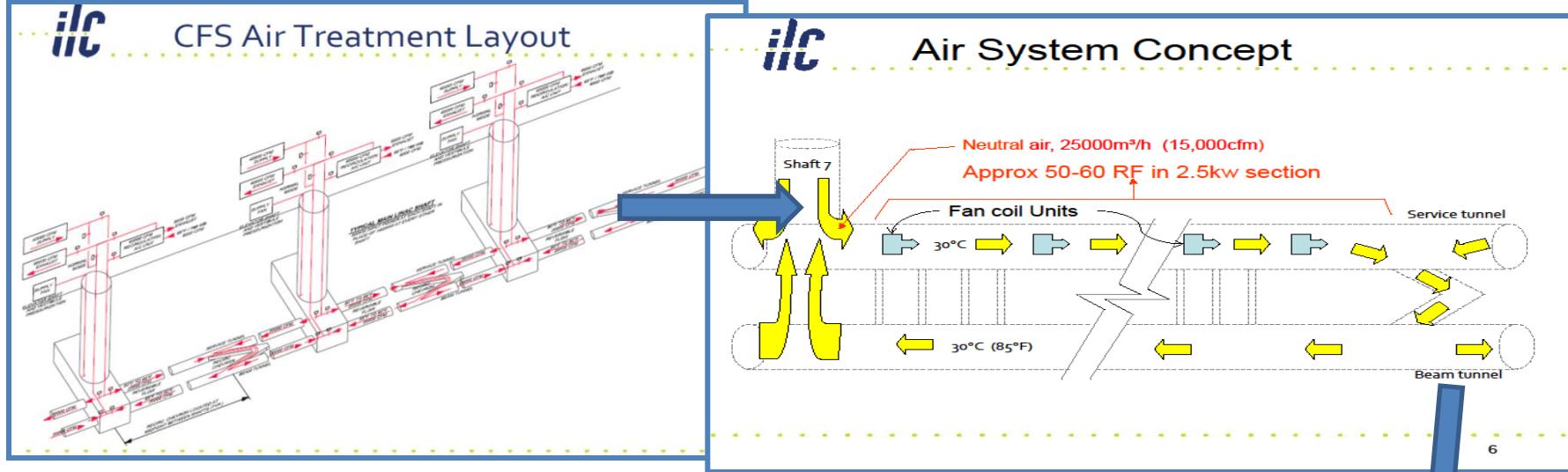
Damping Ring Process water System (Simplified)



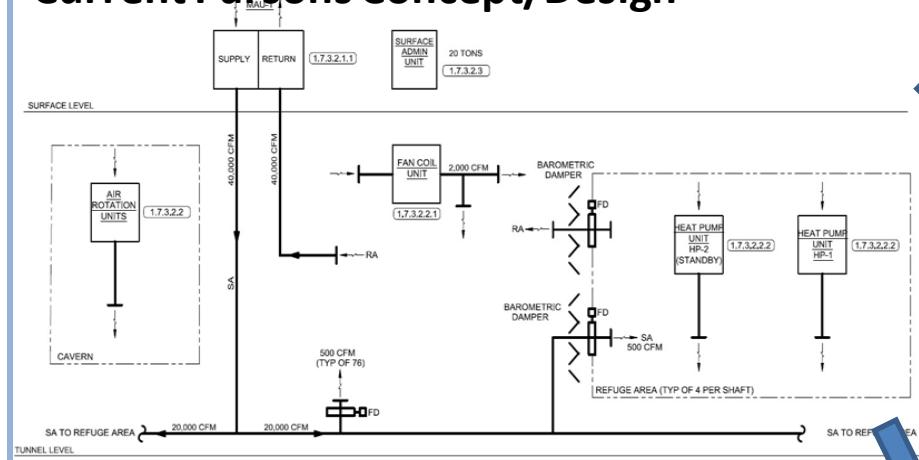
IR & Main Dump Process water System (simplified)



Evolution of the Ventilation System (not a cost driver)

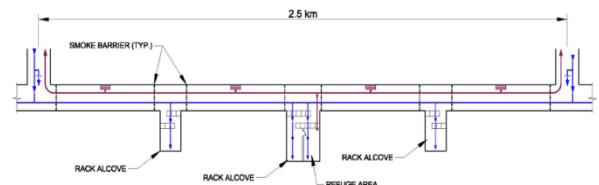


Current Parsons Concept/Design



Single tunnel Airflow

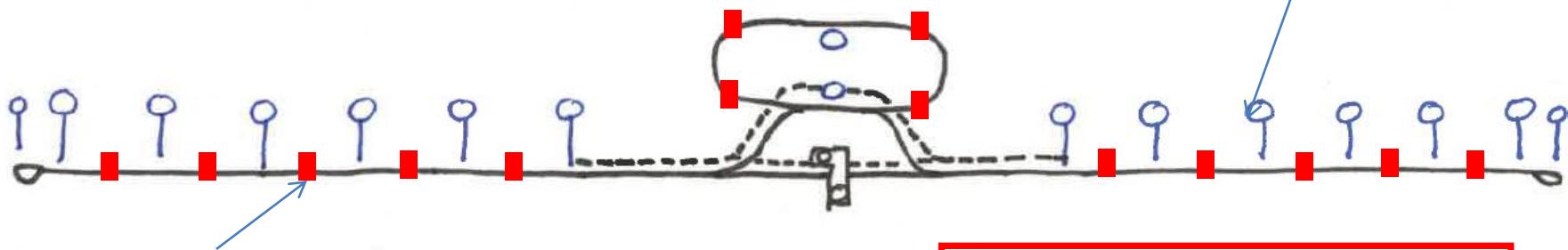
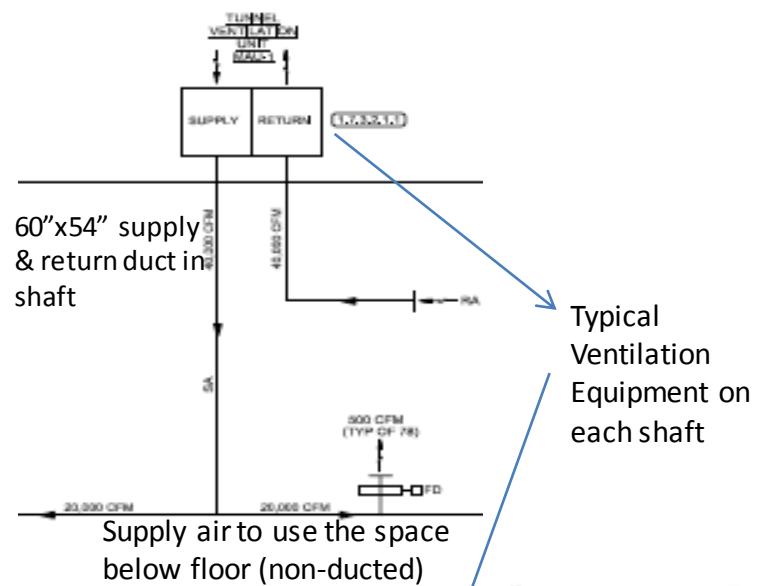
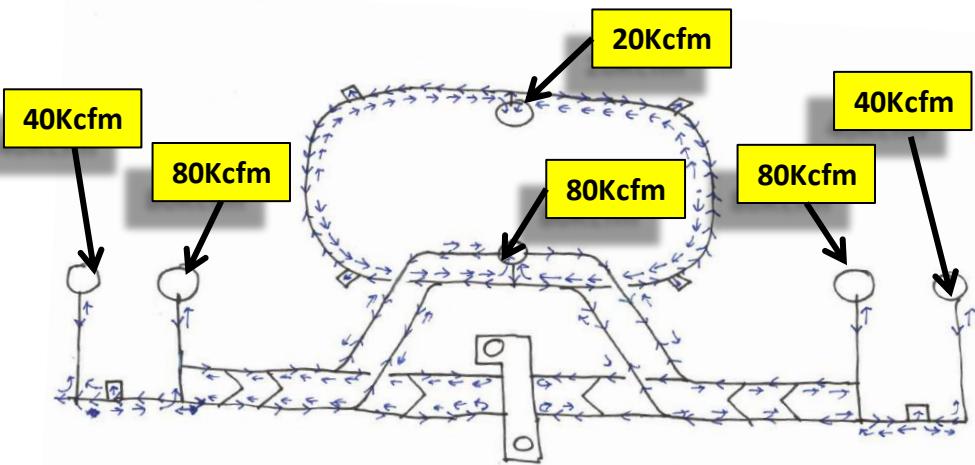
- Air supply into area of refuge and rack alcoves. "Heat to air" in beam tunnel considered to be quite small. 95% reduction from RDR



Current Parsons Design +

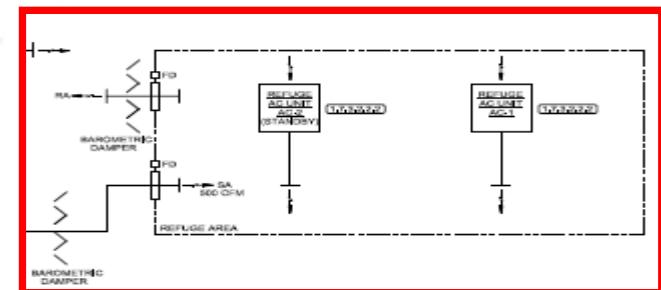
Dedicated ducted supply air system to each Refuge Alcove

AIR TREATMENT SCHEME

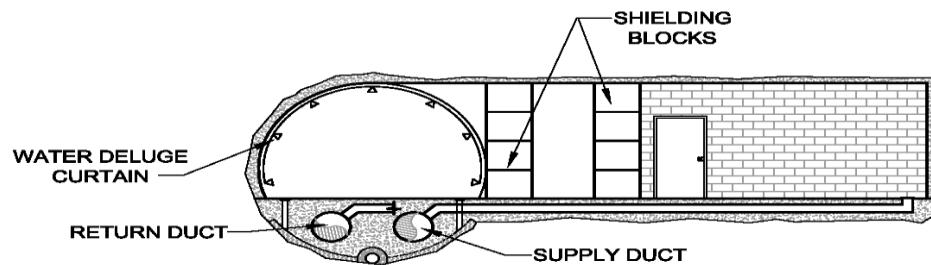
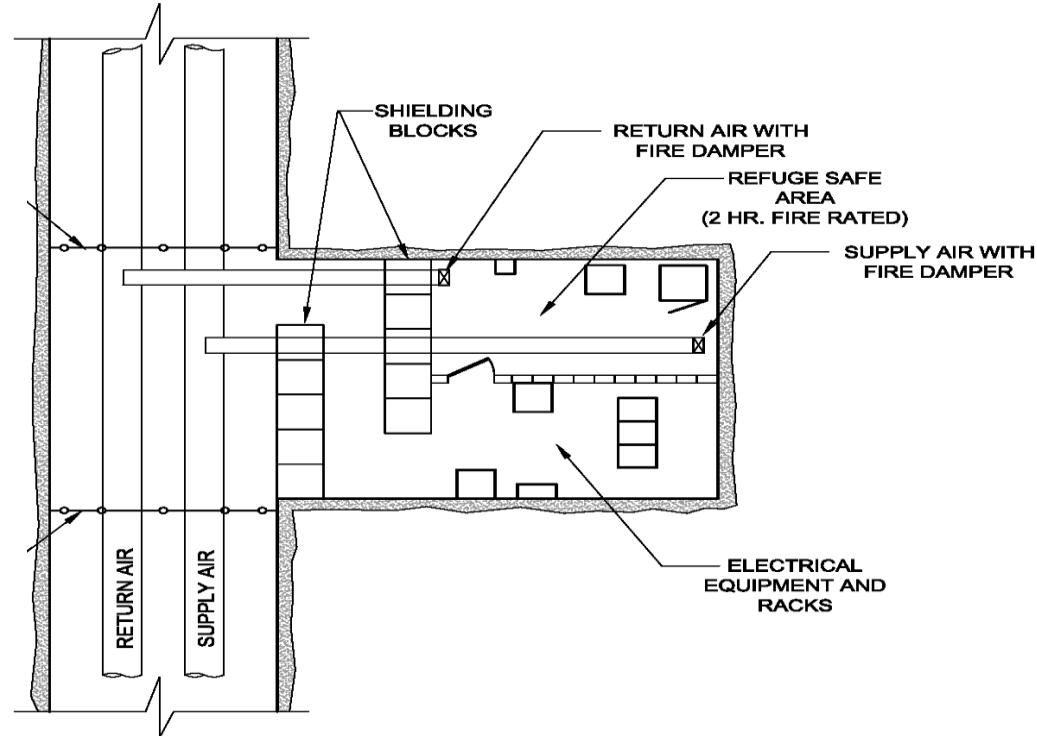


Ducted supply air to each "Refuge Area Alcove"

- ~1mph airspeed (~2 ac/hr)

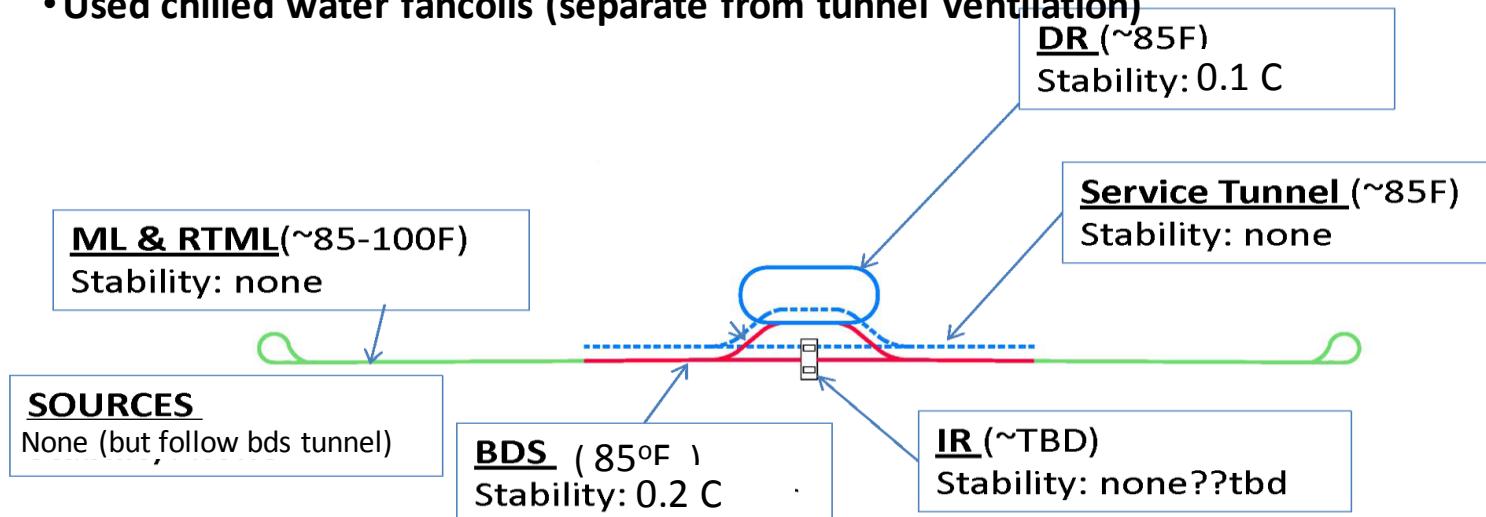


Area of Refuge Layout



SPACE TEMPERATURES and SPACE STABILITY DISCUSSION

- Current placeholders and requirement shown (need updates)
- Expansion consideration for components (beampipes, stands, Alignment)
- Delta T allowed from Beam on to Beam off
- Beamline stabilities (load should be stable)
- Operating temperatures
- Air temperature stability on one location only (at Thermostat)
- No temperature requirement on caverns and shaft
- **Used chilled water fancoils (separate from tunnel ventilation)**



CFS – Beijing ILC Meeting

CHANGES SINCE RDR

Changes due to KCS/single tunnel

Majority of RF load in one location
(major cost savings)

Addition of AOR (minor hvac cost impact)

DR change/Low power/e+

Minor load change (minor)

Other Changes

Chilled water removal in ML/RTML (warm tunnel space warmer)

High Delta T water in RF (minor in KCS)

Add laser room (minor cost/impact)

Detailed cost per shaft instead of scaling

<u>Changes since RDR</u>	<u>Mechanical Cost Impact</u>
single tunnel	(see KCS)
KCS	Significant
DRFS	NA (<i>removed by project</i>)
BC1	NA (<i>back to BC2</i>)
3.2 Km DR	minor (based on load reduction)
CR integration (e+ undulator move)	minor (based on load reduction)
Reduced bunch/Low power	minor (based on load reduction)
VE (high RF water delta T)	minor (not much in KCS)
VE (removal of centralized chilled water system in ML)	significant (<i>warmer ML tunnel</i>)

Conventional Mechanical Equipment QUANTITIES (n+1)																March 19 2012			
Location		PM-12	PM-11	PM-10	PM-9	PM-8	PM-7	PM-7cr	PMC	PMB	PXA	PXB	PM+7cr	PM+7	PM+8	PM+9	PM+10	PM+11	PM+12
surface area	chiller							2+1	2+1	2+1	2+1		2+1						
	chilled pump							2+1	2+1	2+1	2+1		2+1						
	cooling tower-process	3+1	2+1	3+1	2+1	3+1	2+1	2+1	2+1	2+1	2+1	2+1	2+1	2+1	3+1	2+1	3+1		
	cooling tower-cryo		2+1		2+1		2+1		2+1					2+1		2+1		2+1	
	cooling twr pump-process	3+1	2+1	3+1	2+1	3+1	2+1	2+1	2+1	2+1	2+1	2+1	2+1	3+1	2+1	3+1	2+1	3+1	
	cooling twr pump-cryo		2+1		2+1		2+1		2+1		2+1			2+1		2+1		2+1	
	computer ac for racks	2+1	2+1	2+1	2+1	2+1	2+1							2+1	2+1	2+1	2+1	2+1	
	ventilation for RF	4	4	4	4	4	4							4	4	4	4	4	
	DI Tank				1					1						1			
	Heat Exchanger	2+1	2+1	2+1	2+1	2+1	2+1							2+1	2+1	2+1	2+1	2+1	
	lcw pump	2+1	2+1	2+1	2+1	2+1	2+1							2+1	2+1	2+1	2+1	2+1	
tunnel	Make up air-supply	1	1	1	1	1	1	1	1				1	1	1	1	1	1	
	Make up air-return	1	1	1	1	1	1	1	1				1	1	1	1	1	1	
	hvac unit for admin space	1	1	1	1	1	1						1	1	1	1	1	1	
	process pump							2+1					2+1						
	proc wtr heat exchanger							2+1					2+1						
	LCW Heat Exchanger		2+1		2+1		2+1	11(2+1)	2(2+1)	2+1	2+1		11(2+1)	2+1		2+1		2+1	
	lcw pumps		2+1		2+1		2+1	11(1+1)	2(2+1)	2+1			11(1+1)	2+1		2+1		2+1	
	fancoils	100		102		102	147		103				147	102		102		100	
	booster pump	54		54		54			20				54		54		54		
	rml fancoils	3															3		
	rml booster pump	1+1															1+1		
	sump duplex pumps	11	11	11	11	11	11	60	16	16	1		60	11	11	11	11	11	
	grndwtr lift pumps	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1	1+1			1+1	1+1	1+1	1+1	1+1	1+1	
	refuge area hvac		1+1		1+1		1+1		2(1+1)	2(1+1)			1+1		1+1		1+1		

OVERHEAD (peak running KW from Parsons @ full power)

		PEAK RUNNING KW -(BHP to KW)																		March 19 2012			
		HEAT REJECTION- related Mech Equip																					
Location	Equipment	tag	PM-12	PM-11	PM-10	PM-9	PM-8	PM-7	PM-7cr	PMC	PMB	PXA	PXB	PM+7cr	PM+7	PM+8	PM+9	PM+10	PM+11	PM+12			
Surf ace	chiller	CHL-1							854	785	232	37		854							2762		
	chiller	CHL-2							854	785	232	37		854							2762		
	chilled pump	CHWP-1							46	35	15	3		46							145		
	chilled pump	CHWP-2							46	35	15	3		46							145		
	cooling tower	CT-1	22	37	22	37	22	37	37	37	22	11	37	37	37	22	37	22	37	22	535		
	cooling tower	CT-2	22	37	22	37	22	37	37	37	22	11	37	37	37	22	37	22	37	22	535		
	cooling tower	CT-3	22		22		22												22		22	132	
	cooling tower	CT-4cryo		30		30		30		11						30		30		30		191	
	cooling tower	CT-5cryo		30		30		30		11						30		30		30		191	
	cooling twr pump	CWP-1	6	91	13	61	13	61	60	32	12	3	52	60	61	13	61	13	91	6	709		
	cooling twr pump	CWP-2	6	91	13	61	13	61	60	32	12	3	52	60	61	13	61	13	91	6	709		
	cooling twr pump	CWP-3	6		13		13											13		13		64	
	cooling twr pump	CWP-4cryo		69		41		41		9		7				41		41		69		318	
	cooling twr pump	CWP-5cryo		69		41		41		9		7				41		41		69		318	
	computer ac	CRAC-1	67	67	67	67	67	67								67	67	67	67	67	67	804	
	computer ac	CRAC-2	67	67	67	67	67	67								67	67	67	67	67	67	804	
	ventilation	Surf Ventil	67	67	67	67	67	67								67	67	67	67	67	67	804	
	ventilation	Surf Ventil	33	33	33	33	33	33								33	33	33	33	33	33	396	
	lcw pump	LCWP-1	24	67	54	54	54	54								54	54	54	54	67	24	614	
	lcw pump	LCWP-2	24	67	54	54	54	54								54	54	54	54	67	24	614	
tunnel	process pump	PWP-1							290							290						580	
	process pump	PWP-2							290							290						580	
	lcw pump	LCWP-1							198							198						396	
	lcw pump	LCWP1-dr tunl								31	39											70	
	lcw pump	LCWP2-dr tunl								31	39											70	
	lcw pump	LCWP-4		125		70		70		23						70		70		125		553	
	lcw pump	LCWP-5		125		70		70		23						70		70		125		553	
	fancoils	FCU		25		25		25	52		52				52	25		25		25		306	
	booster pump	LCWBP		60		60		60		23						60		60		60		383	
	rtml fancoils	ARU-rtml		55															55			110	
	rtml booster pump	RWBP rtml		56															56			112	
			366	1268	447	905	447	905	2824	1926	715	122	178	2824	905	447	905	447	1268	366	17265		
	technl load used		2.1	21	4.85	17.3	4.85	16.54	11.9	15.1	2.2	2.3	36	9.9	16.54	4.85	17.3	4.85	20.8	1.8	210.18		
	w/w peak		0.15	0.06	0.08	0.05	0.08	0.05	0.19	0.11	0.25	0.05	0.005	0.22	0.05	0.08	0.05	0.08	0.06	0.17	0.08		
	w/w		0.17	0.06	0.09	0.05	0.09	0.05	0.24	0.13	0.33	0.05	0.00	0.29	0.05	0.09	0.05	0.09	0.06	0.20	0.08		
			366	1268	447	905	447	905	996	292	227	42	178	996	905	447	905	447	1268	366	0.05		

Thermal Load in MW

DRAFT MAR 19 2012

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RDR 2006 (in MW)					TDR full power (KCS)				TDR baseline- low power (KCS)			
	LCW	Air/Chw	Cryo (Water Load)	Total	LCW	Air/Chw	Cryo (Water Load)	Total	LCW	Air/Chw	Cryo (Water Load)	Total
e-sources	2.88	1.42	Cryo (water) Load was included in Cryo group estimate during the RDR	4.3	2.88	1.42		4.30	2.88	1.42		4.30
e+sources	17.48	5.33		22.8	5.819	0.64	1.18	7.6	5.819	0.64	1.18	7.6
DR	17.68	1.85		19.5	16.16	1.05	2.52	19.7	11.77	0.78	2.52	15.1
RTML	9.25	1.34		10.6	4.86	0.930	44.20	5.79	3.74	0.673	44.20	4.41
Main Linac	56	21.1		77.1	63.57	13.75		121.5	50.13	10.91		105.2
BDS	10.29	0.98		11.3	9.20	1.23	0.41	10.8	9.20	1.23	0.41	10.8
Major Dumps	36	0		36	22	0	0	22	11	0	0	11
IR	0	0		0	0.2	0.38	1.324	1.90	0.2	0.38	1.324	1.90
Conventional	(included in numbers above)			182	Conventional (tunnel)			3.7	Conventional (tunnel)			3.4
					Conventional (surface)			10.8	Conventional (surface)			9.6
							49.6	208			49.6	173

New numbers since Granada2011

placeholder from RDR (no info)

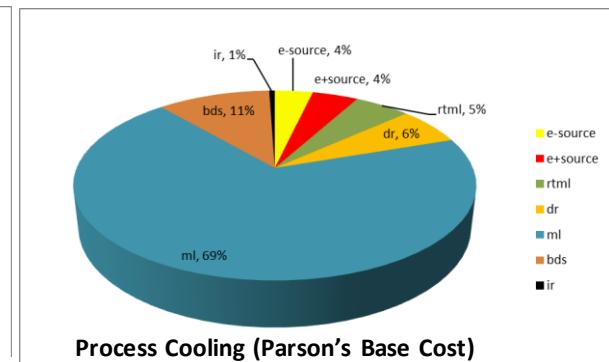
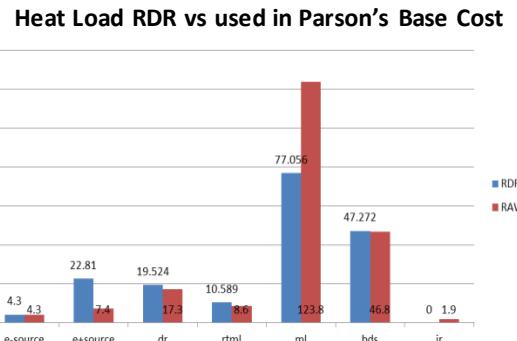
Conventional numbers at peak

20% conventional equip heat load in surface rejected via ventilation not included

SCALING factor (cost reduction of specific WBS) to LOW POWER

DR	23%
RTML	24%
ML	13%

technical Heat Loads- operating peak				
	RDR	used by parsons	full power	low power
e-source	4.3	4.3	4.3	4.3
e+source	22.8	7.4	7.6	7.6
dr	19.5	17.3	19.7	15.1
rtml	10.6	8.6	5.79	4.41
ml	77.1	123.8	121.5	105.2
bds/dumps	47.3	46.8	32.8	21.8
ir	0	1.9	1.9	1.9
	182	210	194	160



Conventional Mechanical RDR vs Parsons Base Cost

