HVAC OVERVIEW and VALUE ENGINEERING ITEMS

August 13, 2008

CLIC Working Group CES

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RDR - Air treatment Design Basis

- **Tunnel Ventilation** Conditioned dehumidified air from surface mounted equipment is ducted into the service tunnel at each shaft. A volume of 15000cfm (425meter³/min) flows at approximately 88fpm (1.6km/hr) to the midpoint between shafts where it is routed into the beam tunnel and returned to the shaft area. Fresh air at a rate of 20% (air change/16hr) is mixed into the air then conditioned and it is recirculated back to the service tunnel. Air volumes for the DR and BDS are similar.
- **Hazardous Conditions** The air direction is reversible and capable of being doubled (unconditioned) during hazardous situations.
- **Design temperature ML** The design temperature for the ML service and beam tunnels is 80-90F (27-32C). ML electronics' heat rejection is mainly to CHW direct cooling and FCUs with small amounts of heat to the ventilation air. AHU and FCUs are used at alcoves and shaft areas.
- **Design temperature DR** The design temperature for the DR tunnel is 104F (40C), using process water fan coil units, and the tunnel wall as a heat rejection source.

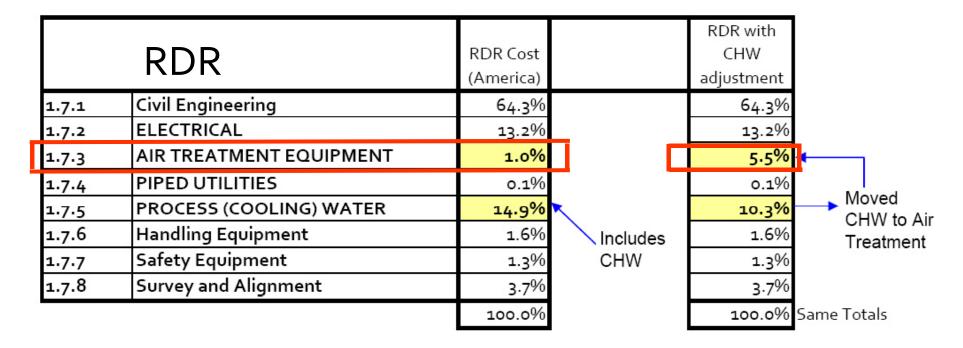
RDR - Air treatment Design Basis

- Design temperature BDS The design temperature for the BDS is 85-90F (29-32C). The low "heat to air" load is mainly absorbed by the tunnel wall. Air mixing fans will be used for temperature stability as required by the BDS.
- Used the basis that airflow could pass from the service tunnel to the beam tunnel through fire/smoke/ODH/radiation protected passages between the tunnels. This assumes that radiation/oxygen deficiency hazards (ODH) do not exist or can be mitigated between the tunnels from the standpoint of air mixing. This item needs concurrence from rad/ODH groups.
- AHU and FCU sizes in the alcoves and tunnels did not consider heat absorption by the rock wall. These units use chilled water from the surface as the heat rejection source.

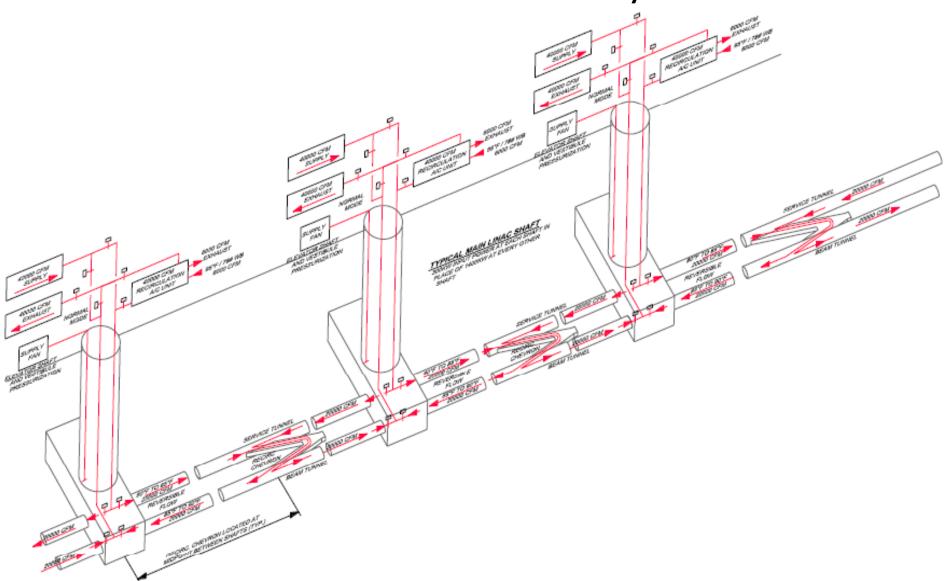
Air Treatment WBS

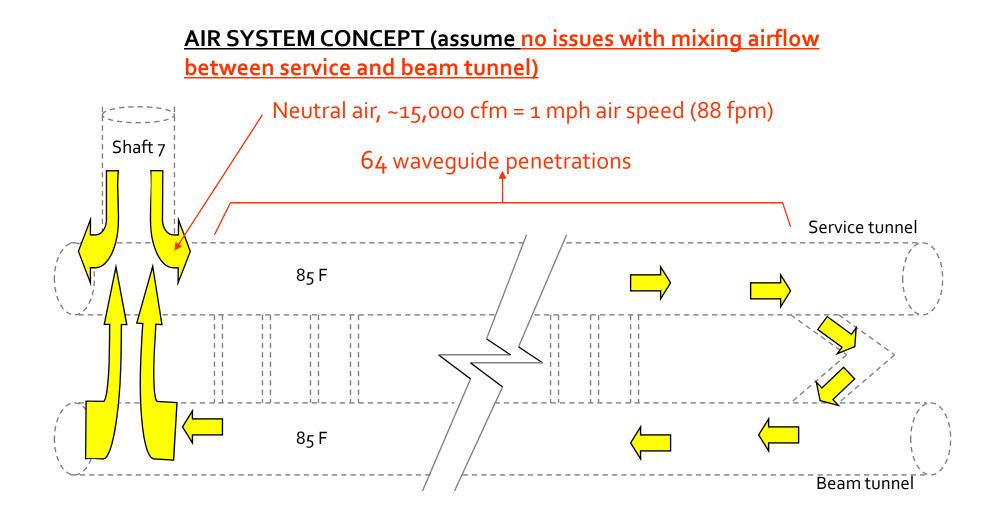
• Air Treatment Cost is about 1% of CFS

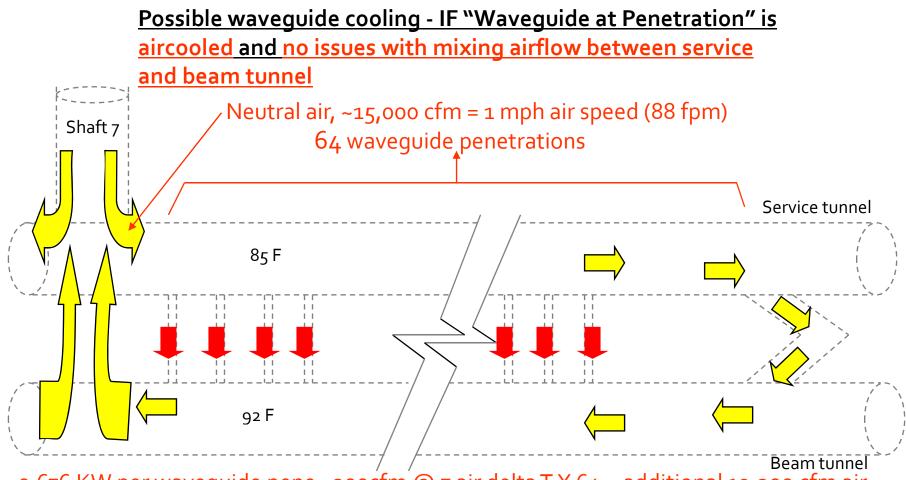
(or 5.5% when CHW system is moved to the air treatment WBS)



CFS Air Treatment Layout







<u>o.676 KW per waveguide pene</u> ~300cfm @ 7 air delta T X 64 = additional 19,200 cfm air

- •Waveguide load in the beam tunnel will **still** need be picked up by fancoils
- Means of air balancing at each penetration needed
- •Some part of tunnel will have ~200 fpm air speed

POST RDR

	Heat Load KW per RF				
	Post RDR Post RD				
	RDR	<u>as of</u> Dec	after Dec		
		07	07		
Service Tunnel (ML RF)					
to water	100	104			
to air	26	21.4			
racks	11.5	11.5			
beam tunnel (ML RF)					
to water	included	included			
to air (wvguide)	0	5.9			
Load to air, servc tunnel, w /m	~ 684				
Servc tunnel temp F	85	104	> 104???		
		85 (cooler			
DR tunnel temperature F	104	LCW)			
Metrology reqmnt (GDE Oct 2007)		< 90F			
Air Stability		+ - 0.1 C			
Water Supply stability		+ - 0.2 C			

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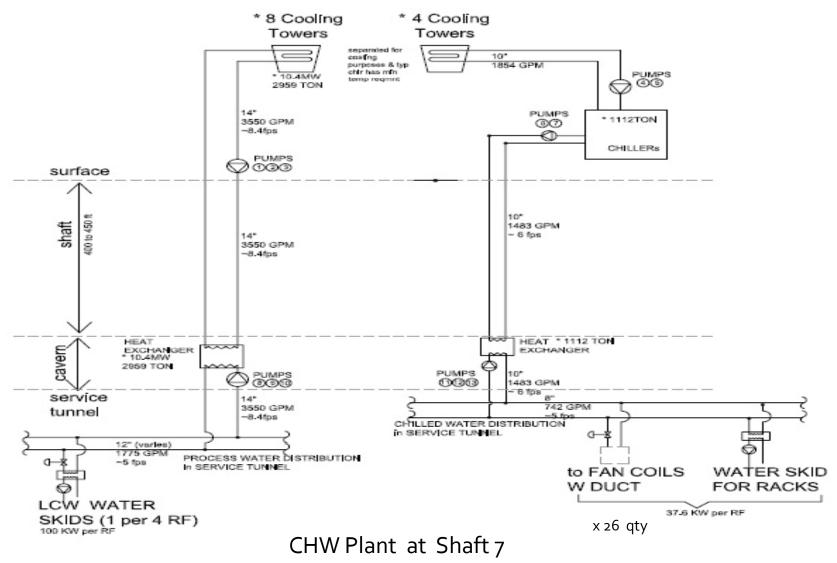
Rock Contribution?

		<u>KW</u> in	Material (K in W/m-	Temp	Tunnel	Temp up to what
Analysis by	W/M	36m RF	K)	in (F)	Dia-m	radius
Ztang - Sep 2006	130		Rock (4.6)	86	5	55F (25m)
Gbowden -Jul 2003	73	-2.63	Earth, Sandstone, Conc (varies)	113	3	77F (10m)
SSC TP/JT - Feb 1985	29	-1.04	Dolomite (3.5)	65	2.5?	55F (30m)
A Enomoto - June 2008	100	-3.60				

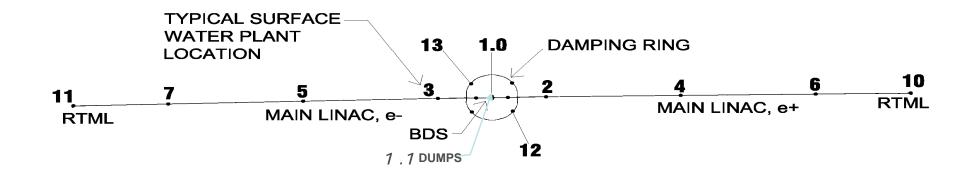
Some discussions and preliminary investigation, but not considered

There still is considerable KW load to the air per RF - chilled fancoils are needed to maintain temperatures

RDR Chilled Water Schematic



Surface Air/CHW Plant locations



Air Treatment Summary

- Air Treatment Components in RDR:
 - Large air handling systems providing heating, cooling, dehumidification, humidification.
 - Fans for air purge, tunnel and shaft pressurization
 - Miscellaneous ducting and accessories, dampers, insulation, etc
- Chilled water systems including chillers, cooling towers, piping and accessories will be moved to the Air Treatment WBS
- Air treatment design is dependent on the ventilation requirements and the heat load criteria received from the area systems
- Air treatment and purge systems have not been fully investigated for radiation and ODH issues. Need further input on air flow configuration concerning radiation and ODH issues
- Air treatment and purge systems configuration were not developed with consensus of any AHJ (authority having jurisdiction, even who this is may not be identified for some time). Need fire protection consultant.

POST RDR

DESCRIPTIONS & "color" legend (DRAFT Dec 18 2007) (G45-Feet may not result to large savings	Villa to
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Diminate one piping system by using process water as primary rejection for chilled water system with jusing modews cooled function, warraw formel (frem 6.15)	
Increase the della T in the LOW and chilled water systems to 30 degrees, reduce flow, pipe size with	C • 1
Lower the temperature in the tunnel to 65 or 70 degrees to increase operating efficiency, extend equipment He, and	Steve Steve
Improve operating environment with Consider use of renewable energy source for use with cogen system with	Steve
Provide a cost analysis for reducing the overall cooling load by 5% and 10% with	Steve
Centralize the cooling system Provide distributed cogen power / cryo (similar to #1.62)	Steve
Decentralize the 345 KV substation function of 18, 20, 38, 4, 29	Tracy
Becirically engineer the distribution system to optimize and reduce cost with	Tracy
Provide connection to electrical utility system at all shafts (w/#2)	Tracy
Optimize substalion spacing w#0	Tracy
Let the electrical utility construct substations and don't include that cost in the project construction cost will	Tracy
Centralize the MVAC and reconfigure air flow from the ends	Les
Pipe two chilled water calls in series, chilled water recision, size one for 30 degree delta T w/P10	Lany
Let the temperature in the turned go to 108 degrees Y during moment operation and focul cool to 85 degrees where people are (consider increased conciles more if equarity peakement)	Kann
Raise turnel temperature in 193 pagness at all times (means OSHA regularements) w#13	Kasa
Provide air conditioned suits for personnel working in tunnel and let the temp go higher than OSHA requirements w#13	Keith
Consider oversizing electrical cables and transformers to reduce heat	Keith
Redesign the RF loads for more optimal process water flow	ALC: N
Modify top shaft HVAC to only process make up air, add blowers down shaft for recirculation Reduce lighting level to egreex limits	Les
Reduce water pressure drop across components, minimize head pressure	Make
Examine possibility of going to 2 condenser water loops instead of 3 as presently planned	Doubl
Consider using low mineral content water instead of LCW w28 (design rester system for low mineral vester)	
	Name:
Allow different types of pipe materials: PVC, CPVC, MOPE, carbon floer wrapped PE, etc.in test of statutes steel	Rick
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Specific V.E. List

•About 50+ list from V.E. in Nov 2007, List from value engineering sessions in Nov 2007. Some appear to have very good cost reduction potential.

•No pros/cons and cost impact evaluation done yet

•Color coded

Red=Marc selected on Dec 4 2007

Yellow=potential VE but not necessarily cost reduction?

Green= by others (HLRF), not CFS

Gray=ignore

White=not sure

•Most VE work effort stopped on Dec 18 07

HVAC/CHW Value Engineering Studies

- Provide one hi-efficiency cogen power/cooling plant on site and distribute power and 33°F (0.6°C) CHW throughout the facility,
 - Removes power/CHW production systems costs from the project cost.
 - Removes one piping system from project.
 - 33°F CHW = smaller pipes, lower HP pumps, smaller HXs, very HI delta T (90°F/50°C+)
 - Cogen plant builder/operator finances, builds, operates, and maintains power plant then sells utility power and CHW to ILC.
 - Allows cooling of tunnel and electronics mitigating high temperature disadvantages.
 - Centralize plant reduces shaft/support area footprints.
- Centralize the HVAC and reconfigure airflow from tunnel ends or center.
- Modify top-of-shaft HVAC to only process make up air, add blowers at tunnel level for recirculation.
- Investigate use of desiccants to dehumidify make up air. Could use heat recovery from cogen plant.
- Investigate alternate piping materials, PVC, copper, HDPE, etc.