CFS EDR KICK OFF MEETING
Process Water

August 23, 2007

Emil Huedem, FNAL
CFS

CFS Process Water-Outline

- The Past (**RDR** Stuff): What's included,wbs,timeline,Concept & Basis, Cost Approach
- The Future (**EDR** stuff): Approach, Optimization items & questions

RDR Process Water WBS

- Process Water is about 15 or 10% of CFS (*when chilled water move to air treatment-*)

RDR		RDR Cost (America)		RDR with CHW adjustment
1.7.1	Civil Engineering	64.3%		64.3%
1.7.2	ELECTRICAL	13.2%		13.2%
1.7.3	AIR TREATMENT EQUIPMENT	1.0%		5.5%
1.7.4	PIPED UTILITIES	0.1%		0.1%
1.7.5	PROCESS (COOLING) WATER	14.9%		10.3%
1.7.6	Handling Equipment	1.6%		1.6%
1.7.7	Safety Equipment	1.3%		1.3%
1.7.8	Survey and Alignment	3.7%		3.7%
		100.0%		100.0%

Includes CHW

Moved CHW to Air Treatment

Same Totals

RDR Process Water WBS

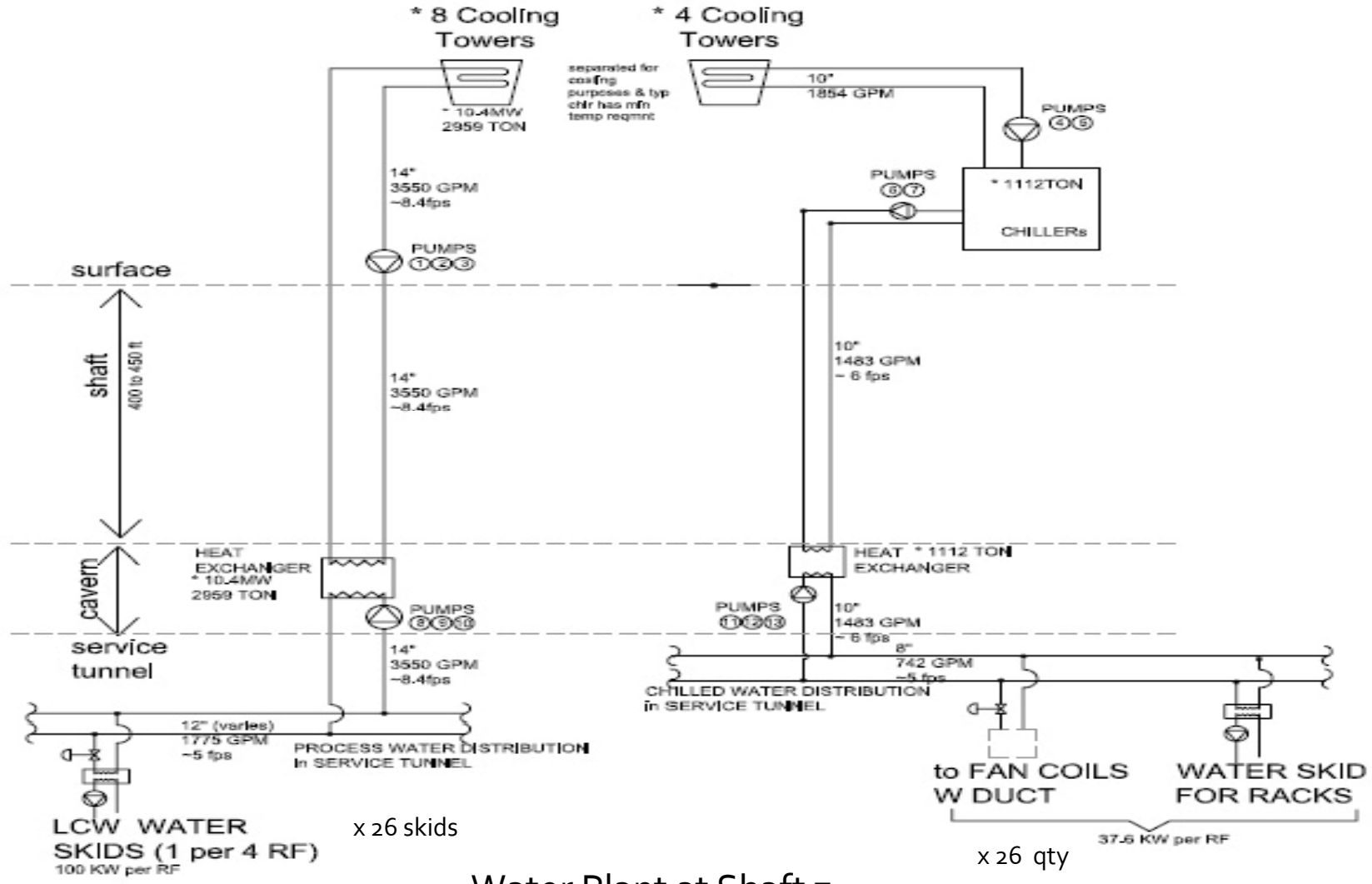
1.7.5 Process Cooling Water

1.7.5.1.1	Engineering, Study Work & Documentation
1.7.5.2.1	Cooling Towers & Pumping Stations
1.7.5.2.2	Primary Stations and Piping
1.7.5.3.1	Demineralized Water Skid
1.7.5.3.2	Chilled Water Stations and Distribution Piping
1.7.5.3.3	Water Stations and Distribution Piping
1.7.5.3.4	Compressed Air
1.7.5.3.5	Process Water Distribution

RDR Process Water subWBS

1.7.5.1.1	**Engineering, Study Work & Documentation**
	Outsourced Engineering
1.7.5.2.1	**Cooling Towers & Pumping Stations**
1.7.5.2.1.1	Cooling Towers for Process Water
1.7.5.2.1.2	Cooling Towers for Chilled Water
1.7.5.2.1.3	Tower Pump & accessories for Process Water
1.7.5.2.1.4	Tower Pump & accessories for Chilled Water
1.7.5.2.1.5	Chilled Water Pump
1.7.5.2.1.5	Controls
1.7.5.2.2	**Primary Stations and Piping**
1.7.5.2.2.1	Chillers
1.7.5.2.2.2	Tower Piping for Process Water (surface)
1.7.5.2.2.3	Tower Piping for Chilled Water (surface)
1.7.5.2.2.4	Tower Piping for Process Water (shaft)
1.7.5.2.2.5	Chilled Water Piping (surface)
1.7.5.2.2.5	Chilled Water Piping (shaft)
1.7.5.3.1	**Demineralized Water Skid**
1.7.5.3.1	Demineralized Skids
1.7.5.3.2	**Chilled Water Stations and Distribution Piping**
1.7.5.3.2.1	Heat Exchangers (cavern)
1.7.5.3.2.2	Distribution Pumps (cavern)
1.7.5.3.2.3	Piping (cavern)
1.7.5.3.2.4	Piping (tunnel)
1.7.5.3.2.5	Piping Connections to End Equipment
1.7.5.3.3	**Water Stations and Distribution Piping**
1.7.5.3.4	**Compressed Air**
1.7.5.3.5	**Process Water Distribution**
1.7.5.3.5.1	Heat Exchangers (cavern)
1.7.5.3.5.2	Distribution Pumps (cavern)
1.7.5.3.5.3	Piping (cavern)
1.7.5.3.5.4	Piping (tunnel)
1.7.5.3.5.5	Piping Connections to End Equipment

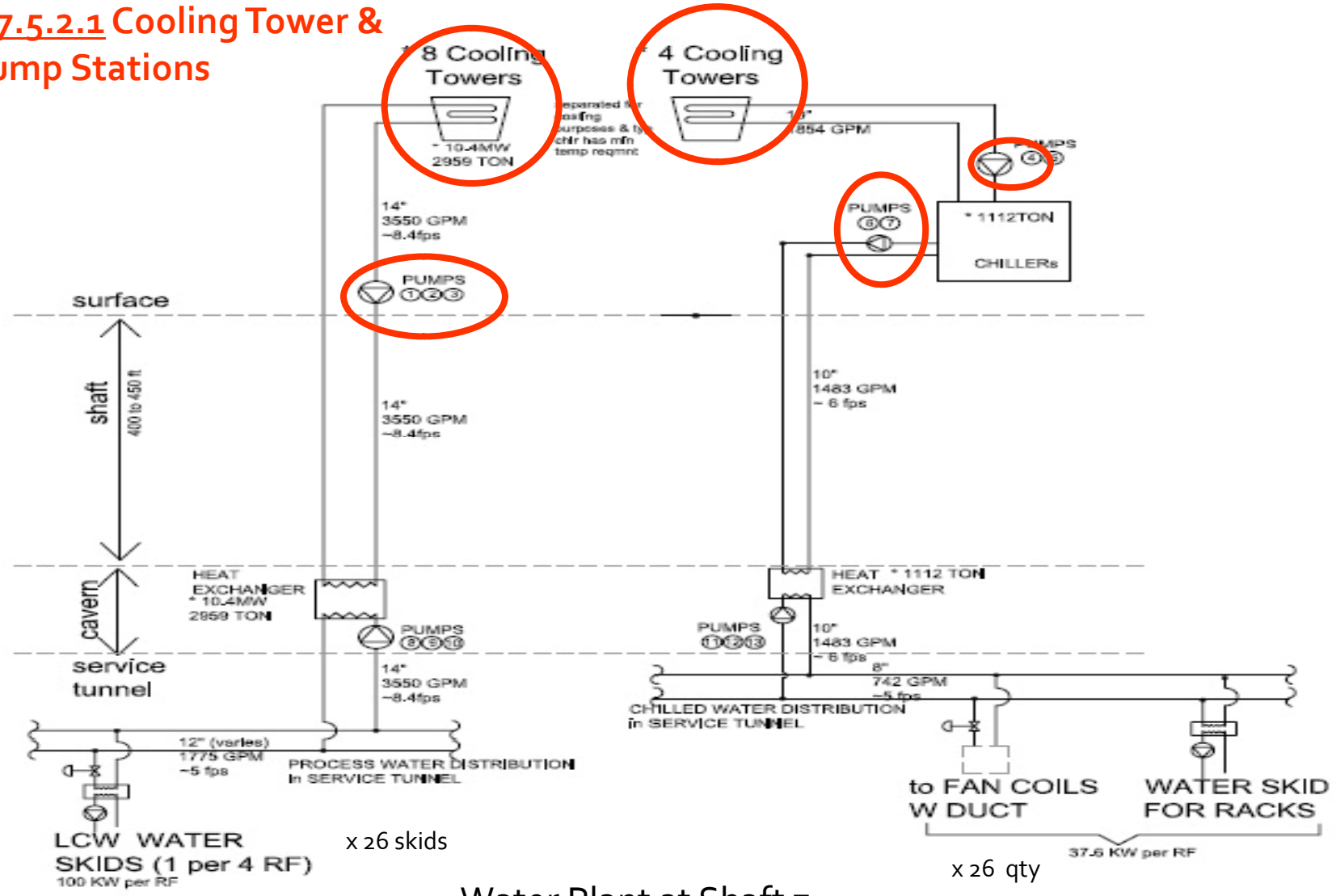
RDR Process Water Schematic



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

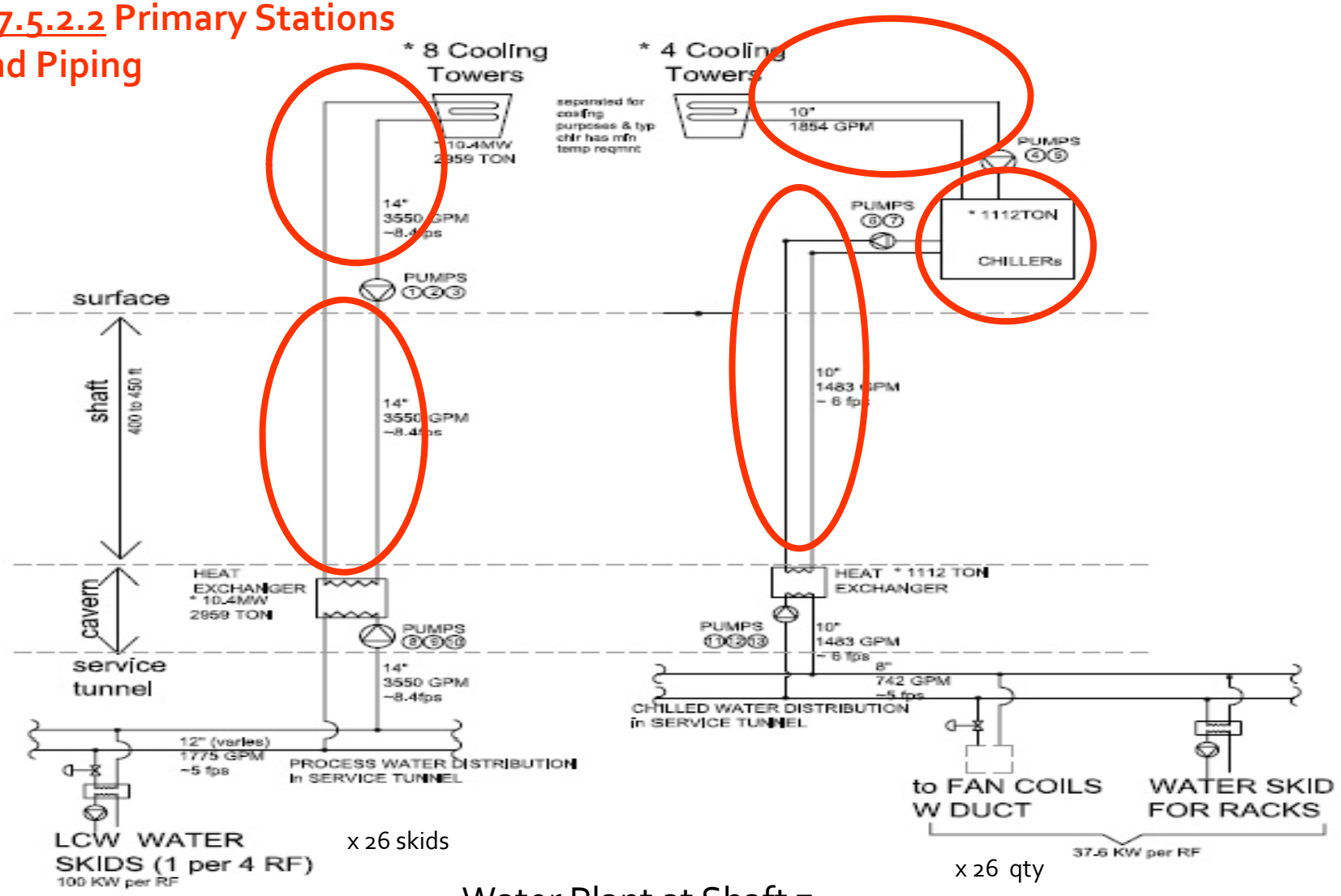
1.7.5.2.1 Cooling Tower & Pump Stations



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

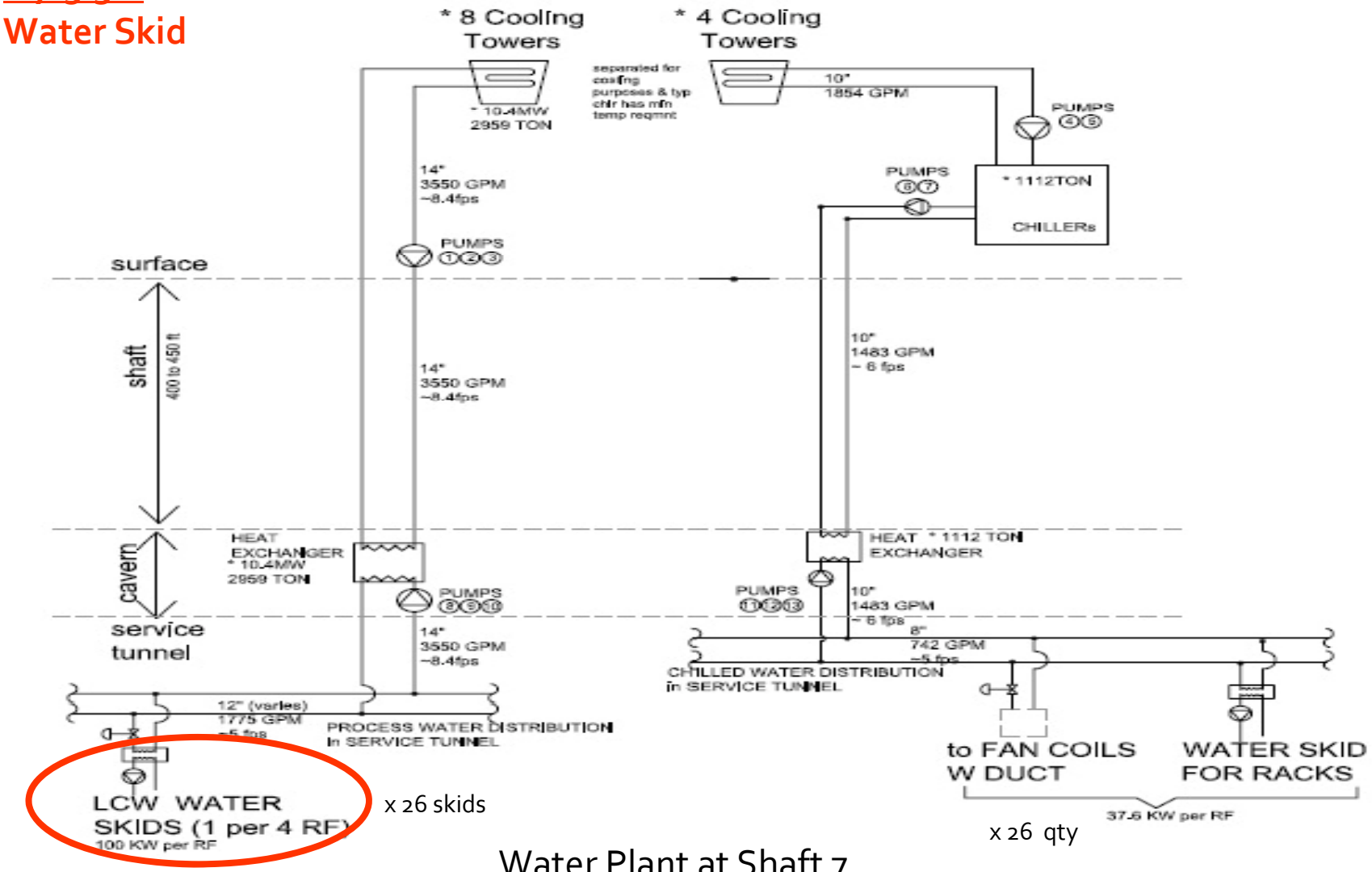
1.7.5.2.2 Primary Stations and Piping



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

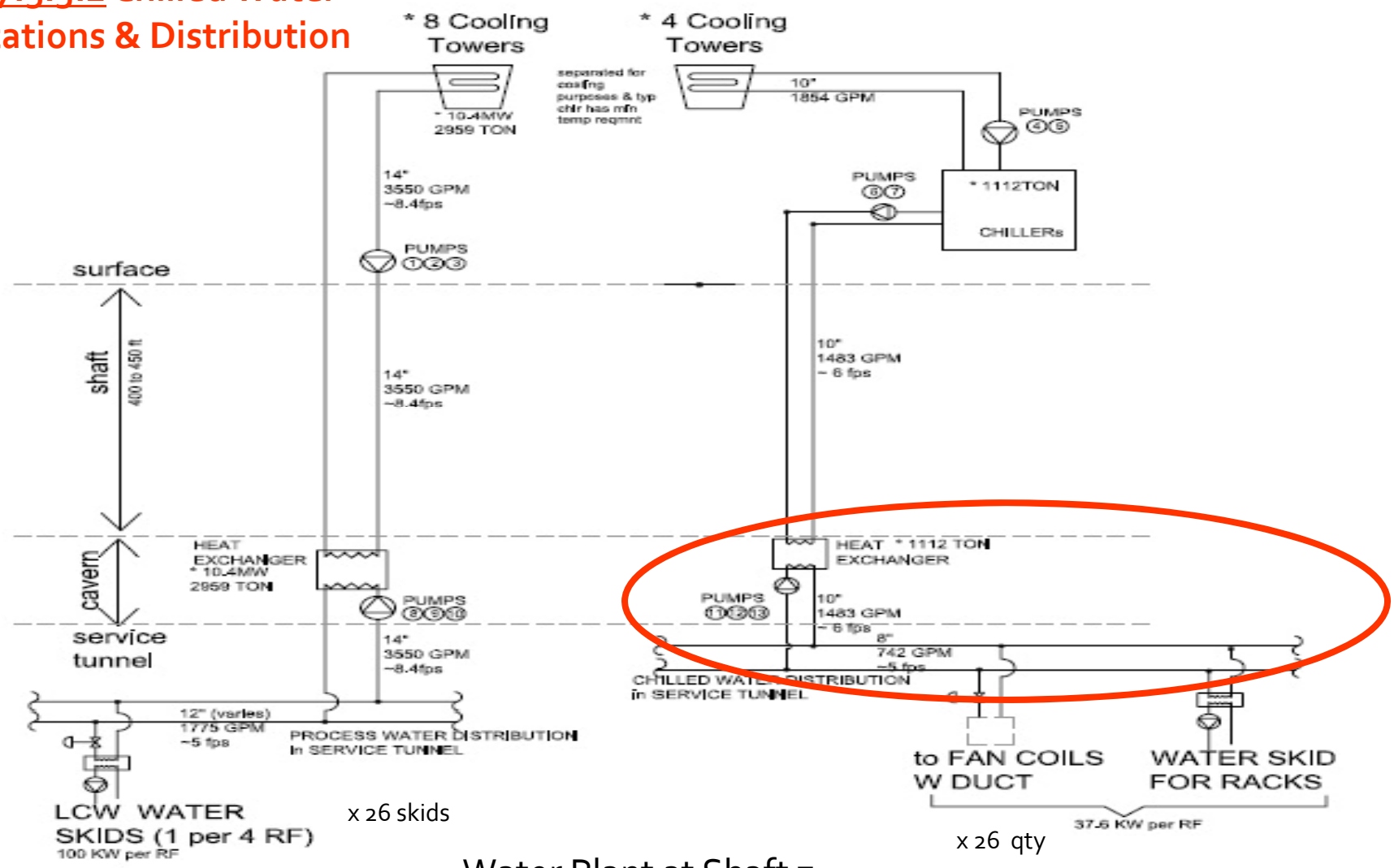
1.7.5.3.1 Demineralized Water Skid



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

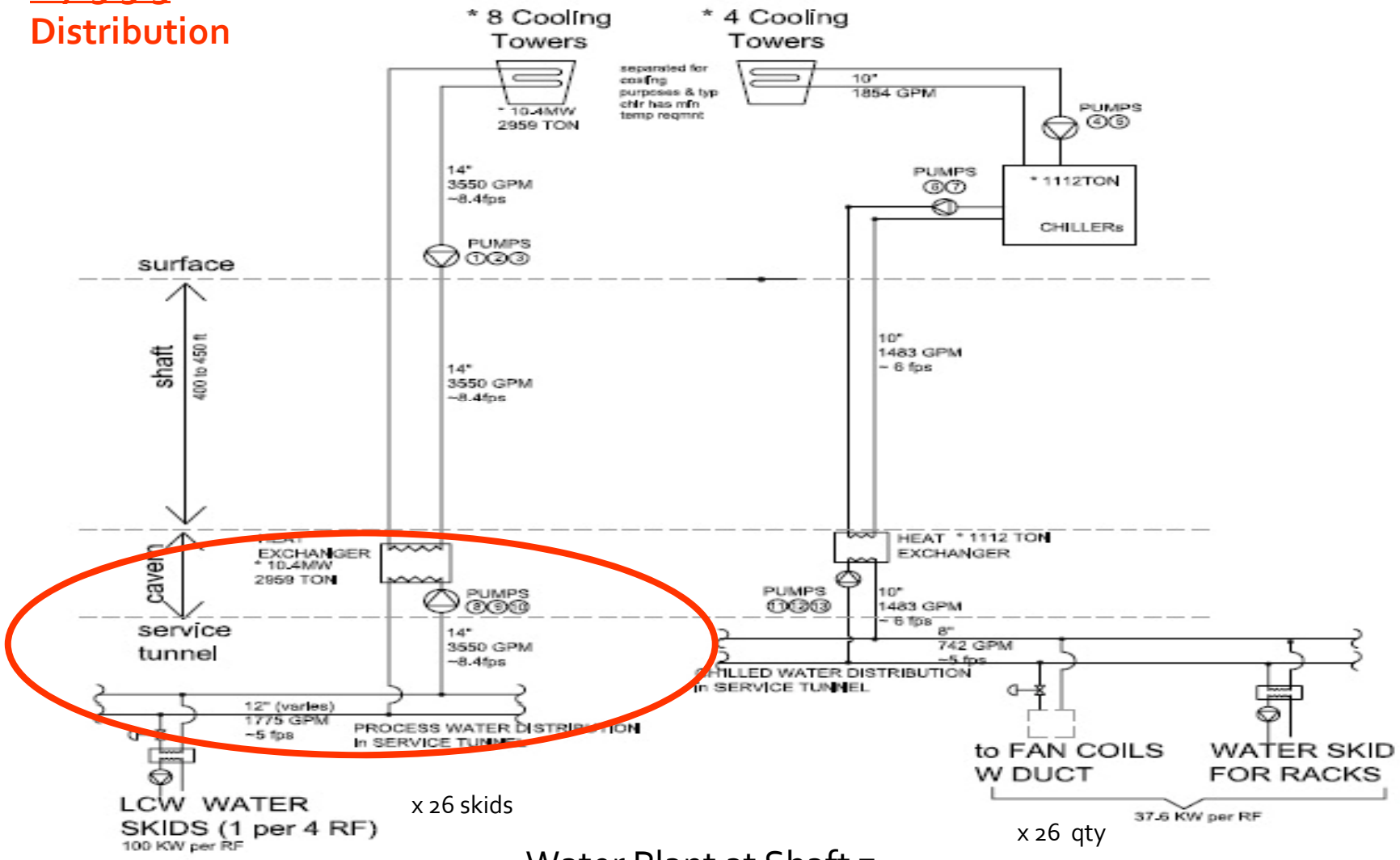
1.7.5.3.2 Chilled Water Stations & Distribution



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

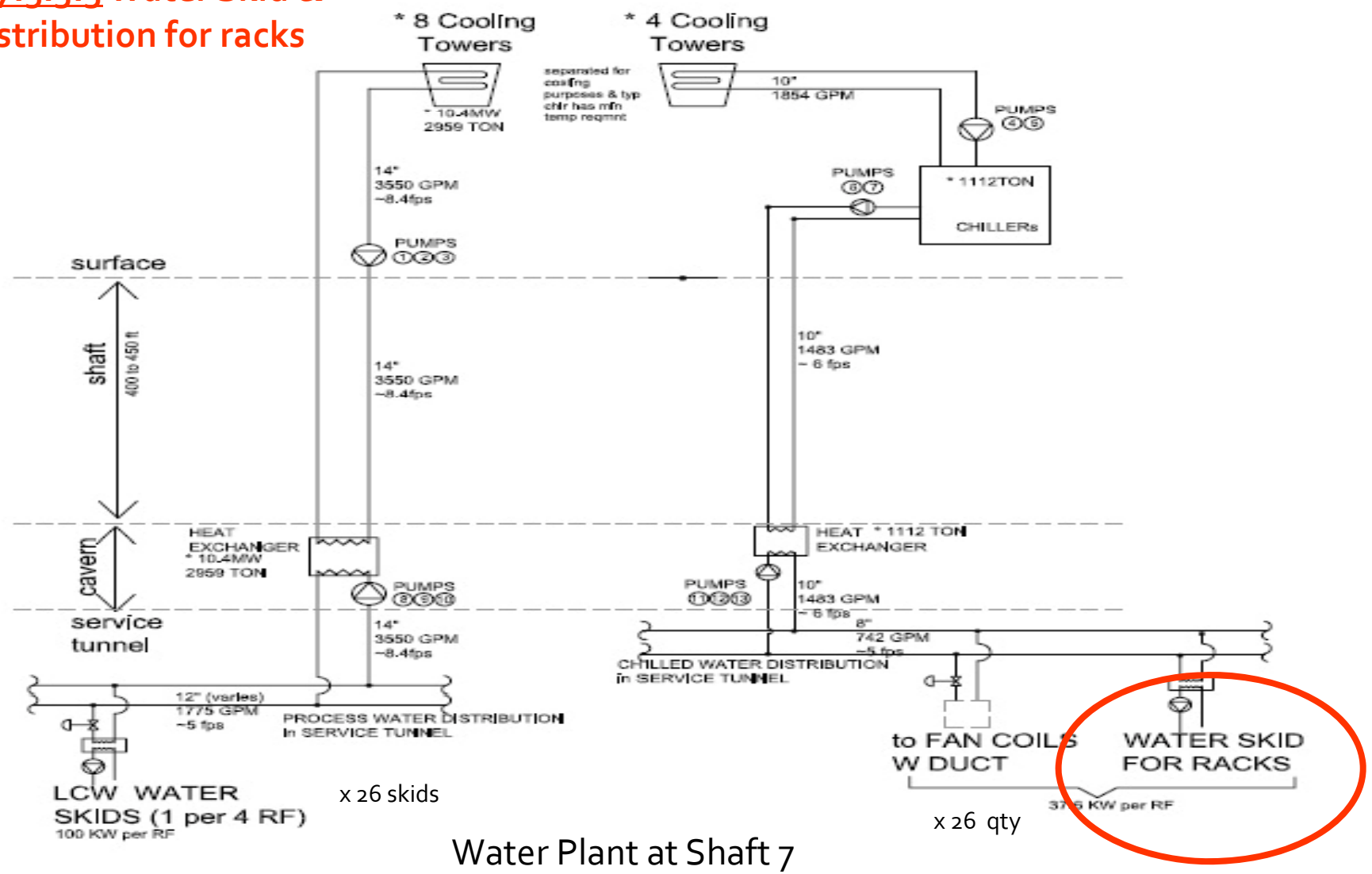
1.7.5.3.5 Process Water Distribution



Water Plant at Shaft 7

RDR Process Water- WBS in Schematic

1.7.5.3.3 Water Skid & distribution for racks



Water Plant at Shaft 7

RDR Process Water- WBS

- Process Water Cost Drivers *(aside from the high thermal load)*

Process (with Chilled Water)		Process Water (with Chilled Water Transferred to Air Treatment)	
Chilled Water Related	28%	Chilled Water Related	0%
LCW Skid & LCW Piping distribution & accessories	38%	LCW Skid & LCW Piping distribution & accessories	55%
Process Piping	12%	Process Piping	17%

RDR Process Water Concept

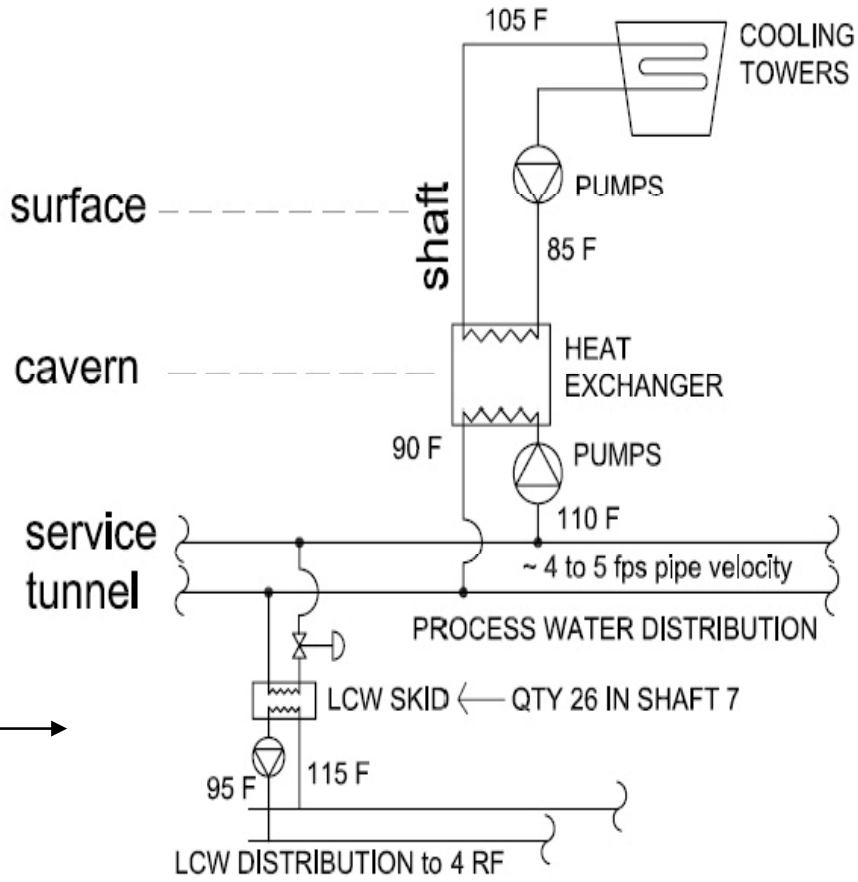
What's included

- Cooling Towers for Process Water/LCW (the chw is separate system)
- Pumps, surface and underground
- Heat Exchanger, LCW skid
- Piping, insulation, valves, controls and other process water accessories

What was NOT included

- Cooling tower system for Cryo

Simplified schematic based on Main Linac RF @ Shaft 7



RDR Process Water Concept

What's included

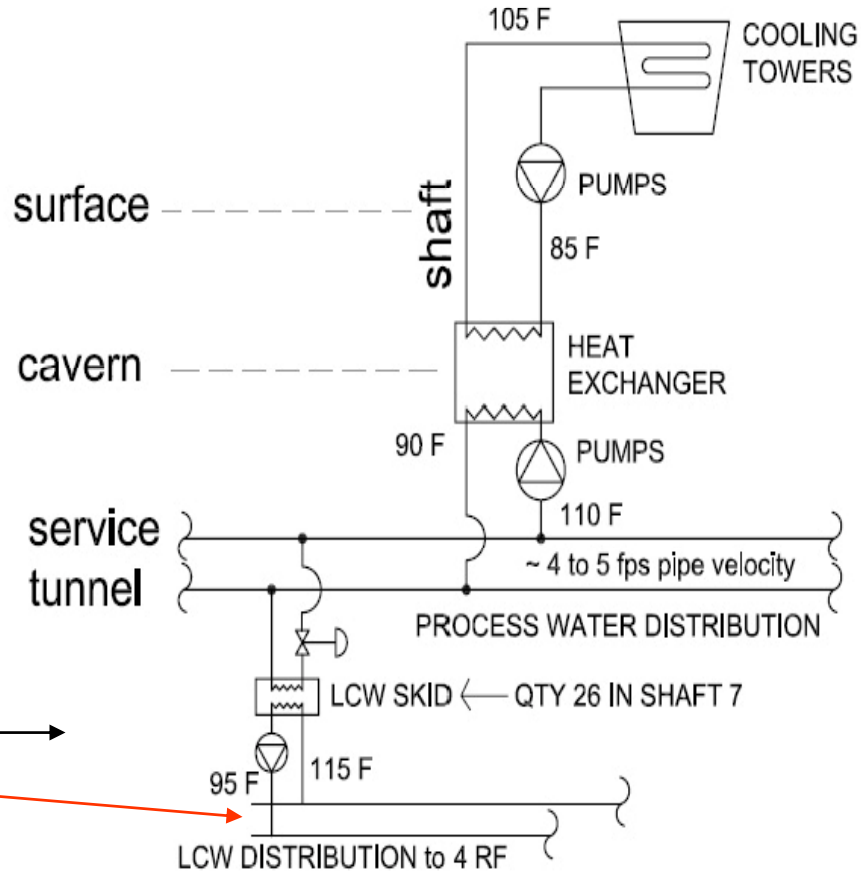
- Cooling Towers for Process Water/LCW (the chw is separate system)
- Pumps, surface and underground
- Heat Exchanger, LCW skid
- Piping, insulation, valves, controls and other process water accessories

What was NOT included

- Cooling tower system for Cryo

Simplified schematic based on Main Linac RF @ Shaft 7

Used 100%LCW



RDR Process Water Concept

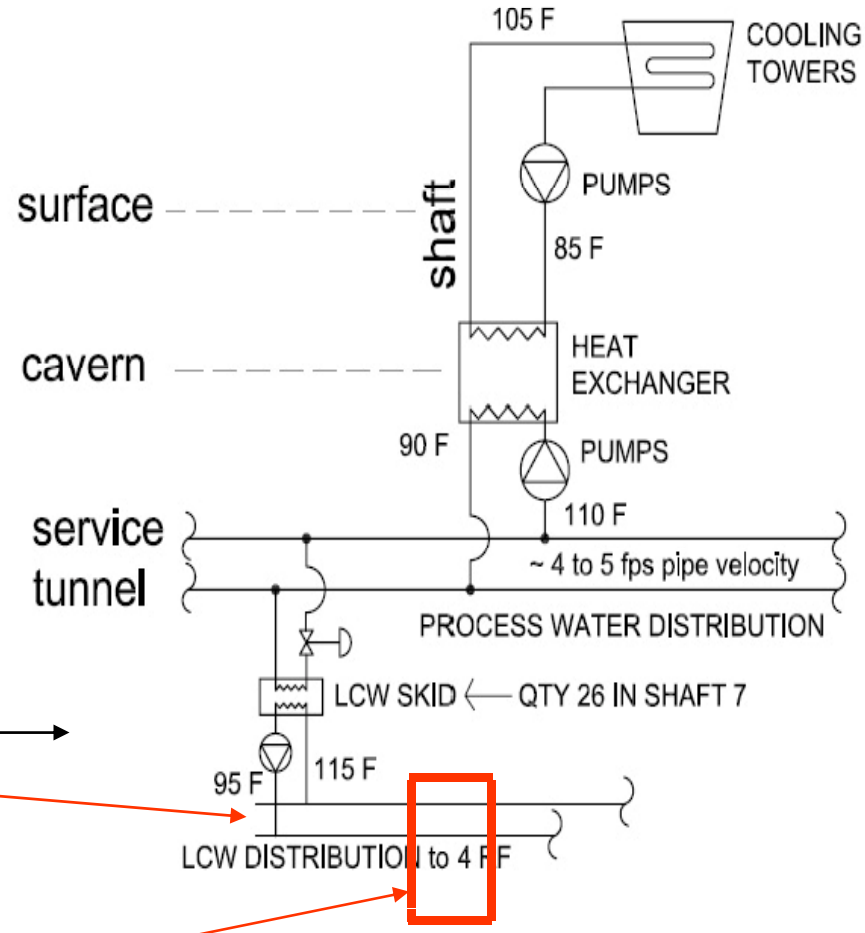
What's included

- Cooling Towers for Process Water/LCW (the chw is separate system
- Pumps, surface and underground
- Heat Exchanger, LCW skid
- Piping, insulation, valves, controls and other process water accessories

What was NOT included

- Cooling tower system for Cryo

Simplified schematic based on Main Linac RF @ Shaft 7



Used 100%LCW

Used 20 F delta T

RDR Process Water Concept

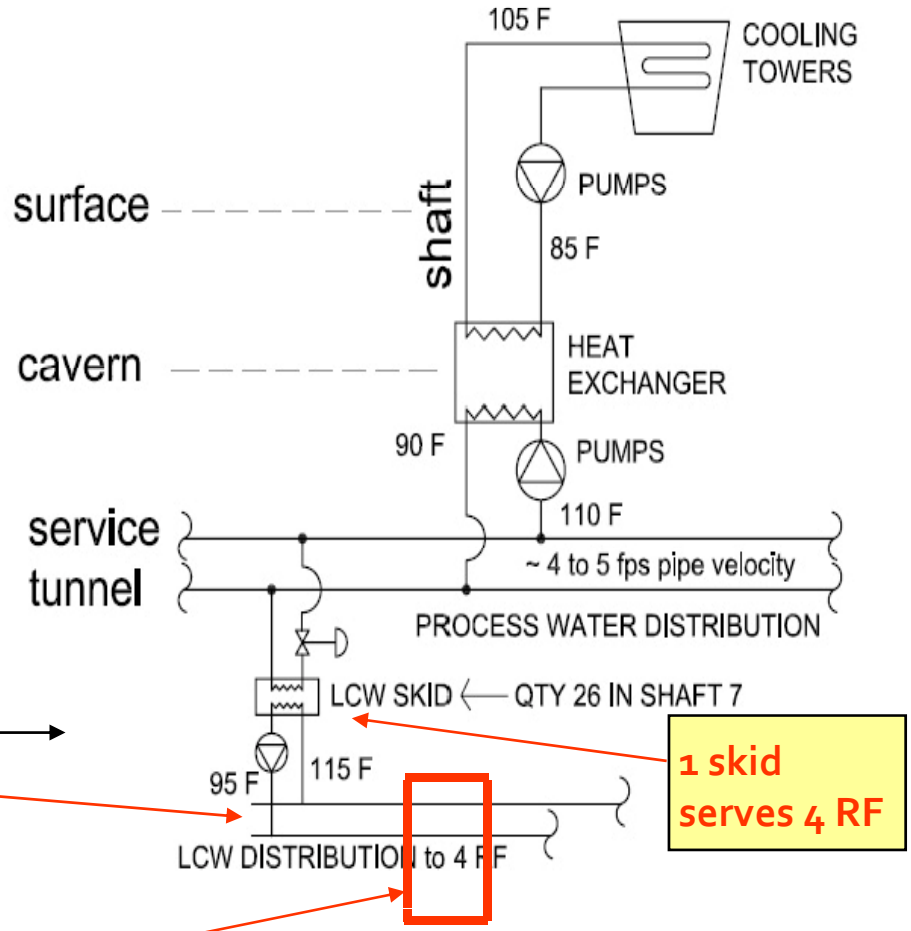
What's included

- Cooling Towers for Process Water/LCW (the chw is separate system
- Pumps, surface and underground
- Heat Exchanger, LCW skid
- Piping, insulation, valves, controls and other process water accessories

What was NOT included

- Cooling tower system for Cryo

Simplified schematic based on Main Linac RF @ Shaft 7



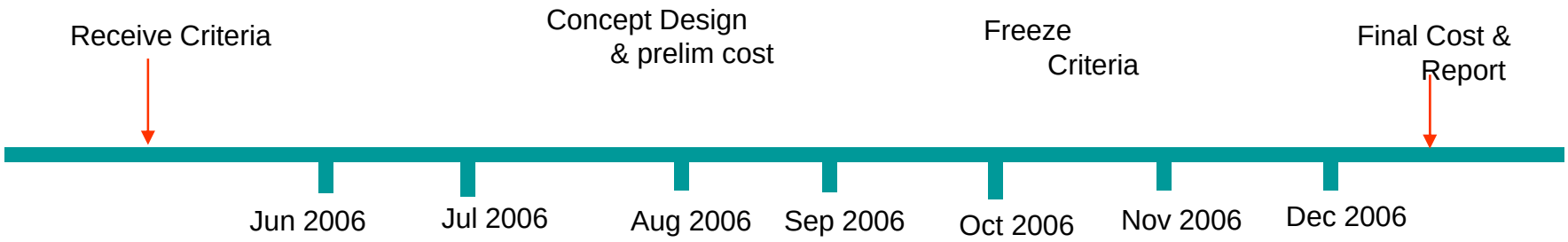
Used 100%LCW

Used 20 F delta T

RDR Process Water – Approach

Basic Approach

- Receive Criteria/requirement
- Design concept
- Cost & Report



Timeline

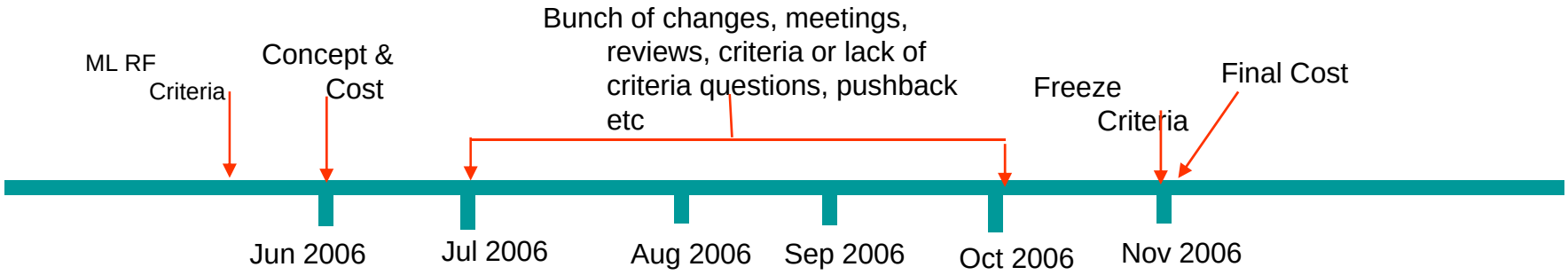
RDR Process Water- Approach

Basic Approach

- Receive Criteria/requirement
- Design concept
- Cost & Report

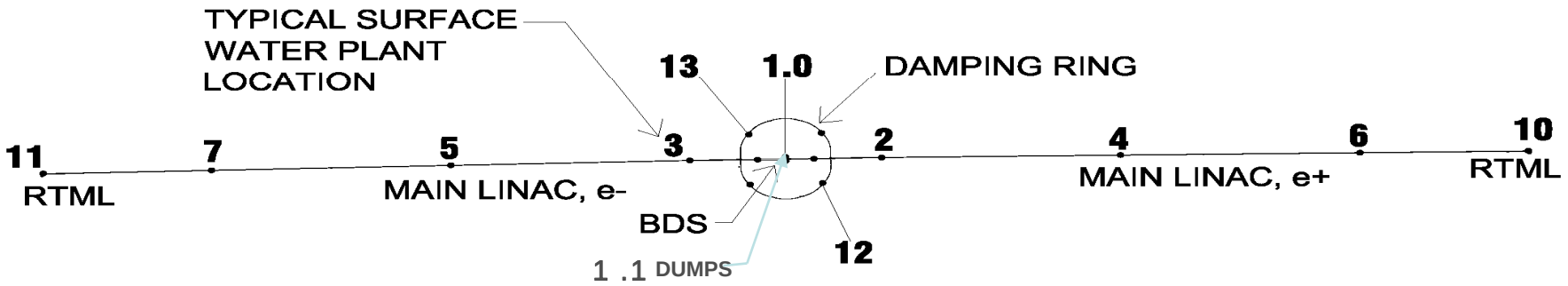
Actual

- ML RF info, the rest of area systems are just totals
- ML RF Concept for 1 shaft
- Concept and cost for other areas (except surface distribution to BDS dumps) scaled from ML RF at Shaft 7



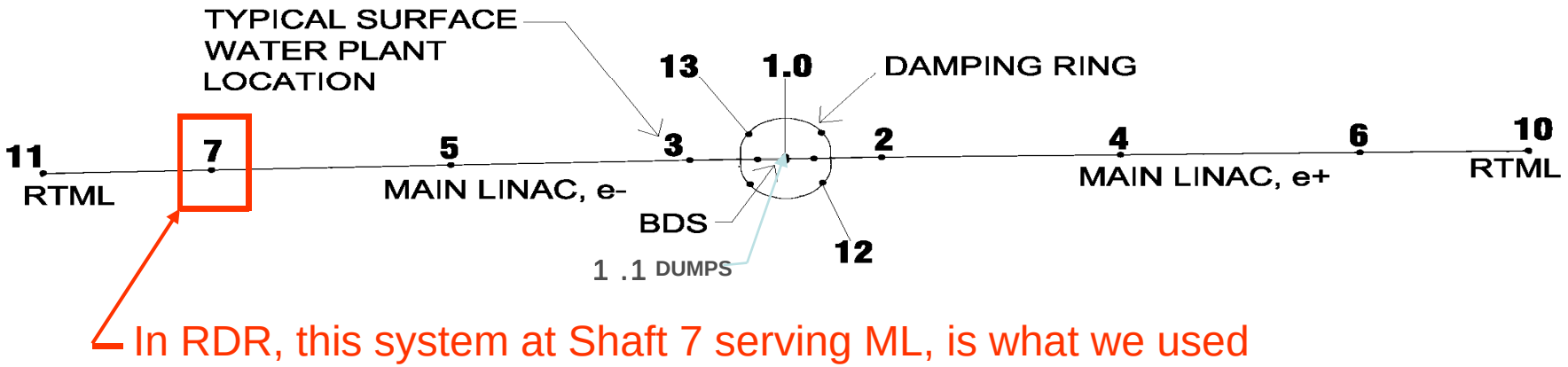
Timeline

RDR Surface Water Plant locations



In RDR, we used simplified distribution by Area System

RDR Surface Water Plant locations



In RDR, we used simplified distribution by Area System

RDR Process Water: Cost Basis

- Used R.S.Means Cost Book for typical HVAC items such as piping, insulation etc
- Used historical data similar project where available
- Used vendors budgetary quote for large items not in R.S.Means. Such as Cooling Towers, Heat Exchangers, Pumps, Rack Skids, LCW Skids
- Used rule of thumb cost per size (example Chiller)

RDR Process Water: Heat Load Basis- ML RF

Nov 27b 2006

WATER AND AIR HEAT LOAD (all LCW) and 9-8-9 ML

Snapshot

Nov 27 2006

Components	Total Heat Load (KW)	Average Heat Load (KW)	To Low Conductivity 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)	keith Jobe load to air Nov 22 06: Power fraction to Tunnel Air (0-1)	Power to Tunnel Air (KW)
RF Components											
RF Charging Supply 34.5 Kv AC-8KV DC	4.0	4.0	2.8	40	40	18	8	10	0	0.3	1.2
Switching power supply 4kV 50kW	7.5	7.5	4.5	35	14	13	8	10	0	0.4	3.0
Modulator	7.5	7.5	4.5			28.82			0	0.4	3.0
Pulse Transformer	1.0	1.0	0.7						0	0.3	0.3
Klystron Socket Tank / Gun	1.0	1.0	0.8						0	0.2	0.2
Klystron Focusing Coil (Soler	4.0	4.0	3.6						0	0.1	0.4
Klystron Collector	58.9	47.2	45.8	*35>			2		0	0.0	1.4
Klystron Body			0.0	*35>			5	+ - 2.5 C	0		
Klystron Windows			0.0	*35>			1		0		
Relay Racks (Instrument Racks	10.0	10.0	0.0	N/A	N/A	N/A	N/A	None	11.5	-0.2	-1.5
Circulators, Attenuators & Dun	42.3	34.0	32.3					+ - 2.5 C	0	0.1	1.7
Waveguide	3.9	3.9	3.5					+ - 2.5 C	0	0.1	0.4
Total RF			100						11.50		26.07

Total Heat load to Dirty Water (per RF)		
Heat load to Chilled water (per RF)	37.6	cooled by chilled water
Heat load to LCW (per RF)	100.0	cooled by low conductivity water

RDR Process Water: Heat Load Basis- ML RF-missing Info

Nov 27b 2006

WATER AND AIR HEAT LOAD (all LCW) and 9-8-9 ML

Snapshot

Nov 27 2006

Components	Total Heat Load (KW)	Average Heat Load (KW)	To Low Conductivity 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)	keith Jobe load to air Nov 22 06: Power fraction to Tunnel Air (0-1)	Power to Tunnel Air (KW)
RF Components											
RF Charging Supply 34.5 Kv AC-8KV DC	4.0	4.0	2.8	40	40	18	8	10	0	0.3	1.2
Switching power supply 4kV 50kW	7.5	7.5	4.5	35	14	13	8	10	0	0.4	3.0
Modulator	7.5	7.5	4.5			28.82			0	0.4	3.0
Pulse Transformer	1.0	1.0	0.7						0	0.3	0.3
Klystron Socket Tank / Gun	1.0	1.0	0.8						0	0.2	0.2
Klystron Focusing Coil (Soler	4.0	4.0	3.6						0	0.1	0.4
Klystron Collector	58.9	47.2	45.8	*35>			2		0	0.0	1.4
Klystron Body			0.0	*35>			5	+ - 2.5 C	0		
Klystron Windows			0.0	*35>			1		0		
Relay Racks (Instrument Racks	10.0	10.0	0.0	N/A	N/A	N/A	N/A	None	11.5	-0.2	-1.5
Circulators, Attenuators & Dun	42.3	34.0	32.3					+ - 2.5 C	0	0.1	1.7
Waveguide	3.9	3.9	3.5					+ - 2.5 C	0	0.1	0.4
Total RF			100						11.50		26.07

Total Heat load [illegible] (per RF)		
Heat load to Chilled water (per RF)	37.6	cooled by chilled water
Heat load to LCW (per RF)	100.0	cooled by low conductivity water

Need more info

Too high?

Review delta P

RDR Process Water: Heat Load Basis- Total Loads

Snapshot Nov 27 2006

Area System	LCW	Chilled Water	**Total**
SOURCES e-	2.880	1.420	**4.300**
SOURCES e+	17.480	5.330	**22.810**
DR e-	8.838	0.924	**9.762**
DR e+	8.838	0.924	**9.762**
RTML	9.254	1.335	**10.589**
MAIN LINAC	56.000	21.056	**77.056**
BDS	10.290	0.982	**11.272**
DUMPS	36.000	0.000	**36.000**
	149.58	*31.971*	**182**

RDR Process Water Summary

- Process Water Components in RDR were
  - Process Water and Low Conductivity Water & related accessories
  - Chilled water System (*this will be transferred to Air Treatment Systems, in EDR*)

- Process Water design is dependent on the heat load info received from area systems. Concept, scope and cost was based on **whatever** information we have as of Nov 2006.

- In RDR, we conceptualized and costed one water plant (at shaft 7) and everything else was scaled from that, based on each area's heat load. There were no detailed distribution concept for the other area system, except for the process water distribution to BDS dump,which was a near surface piping distribution toward individual utility shaft to each water dump cavern

- LCW is still immature in design. Used 100% LCW for RF components, as basis (instead of pushback version of 1%LCW/99% non-lcw water), because there was no concurrence as of Nov 2006 from various users to use the pushback-non-lcw, and the preliminary savings was not large.

- Cost/power reduction items were initiated, (even with loose and incomplete criteria at that time), the system design is still immature, with a lack of detailed specifications and requirements. Value engineering has been deferred.

EDR Process Water Summary

- Process Water Components in EDR is
  - Process Water and Low Conductivity Water and related accessories

- The **snapshot** info/criteria we had on Nov 2006 will be updated. Hopefully there will be a more complete updated criteria very early.

- In EDR, we will conceptualize and cost plants for all area systems instead of scaling approach used in RDR

- The use of LCW (& all other potential optimization items) will have to be revisited. We assumed though, LCW will be the starting point of the baseline and the variation (LCW vs Non-Lcw) will be decided by "someone" before they passed it on to CFS, maybe after the fight between the pros and con group on this issue (or "value engg").

EDR Process Water- Basic Approach

- Receive/Update criteria & requirement

EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)

EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design

EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc)

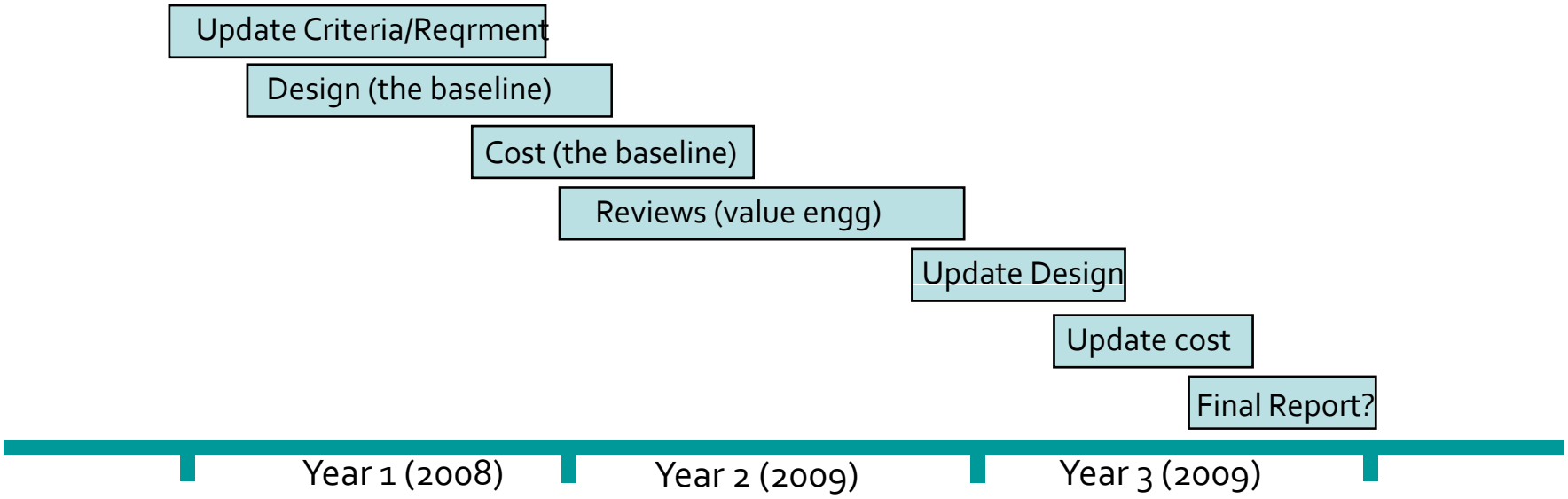
EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc)
  - Update criteria
  - Update baseline
  - Update cost

EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc) & updated design/cost

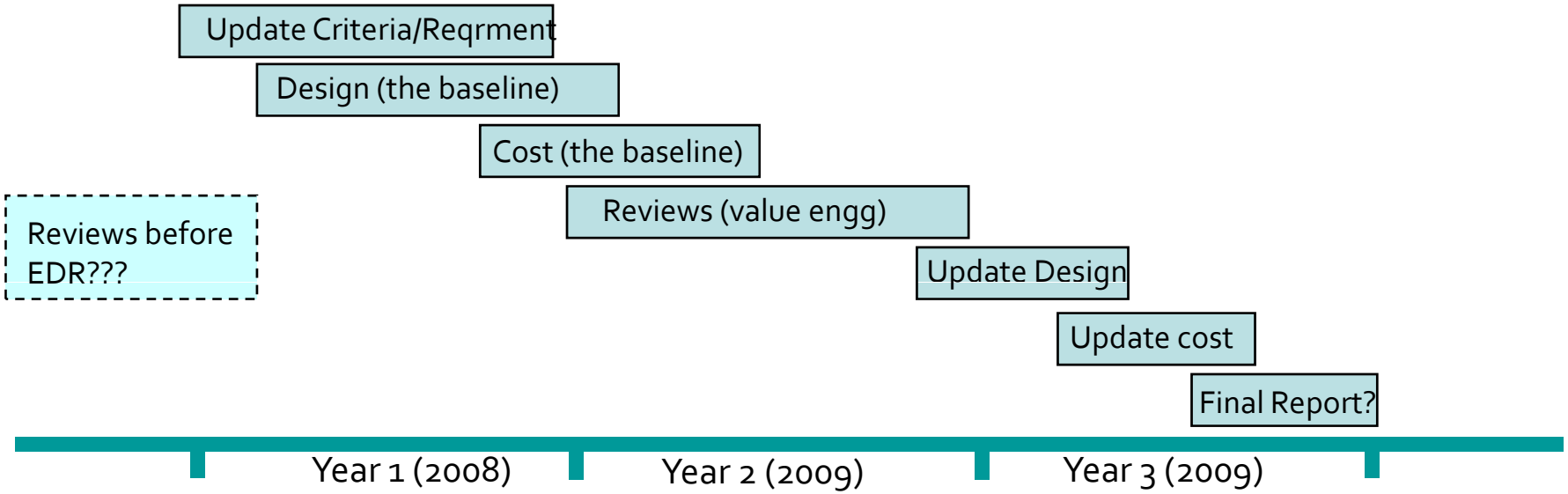
We have the next two or three years to do this



EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc) & updated design/cost

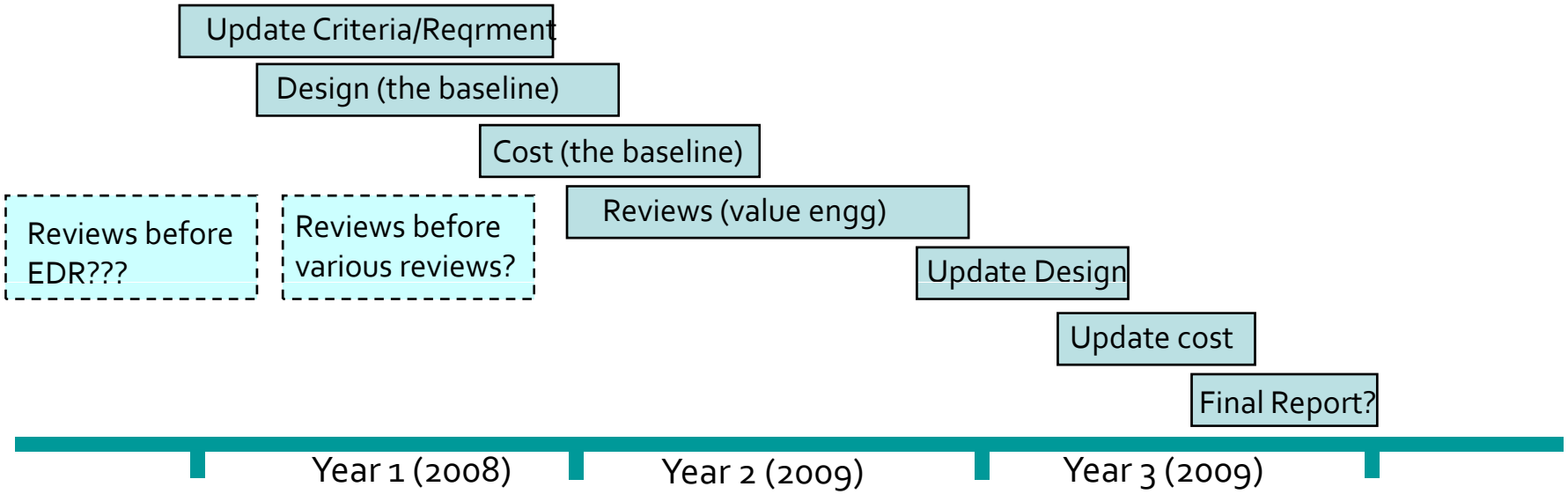
We have the next two or three years to do this



EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc) & updated design/cost

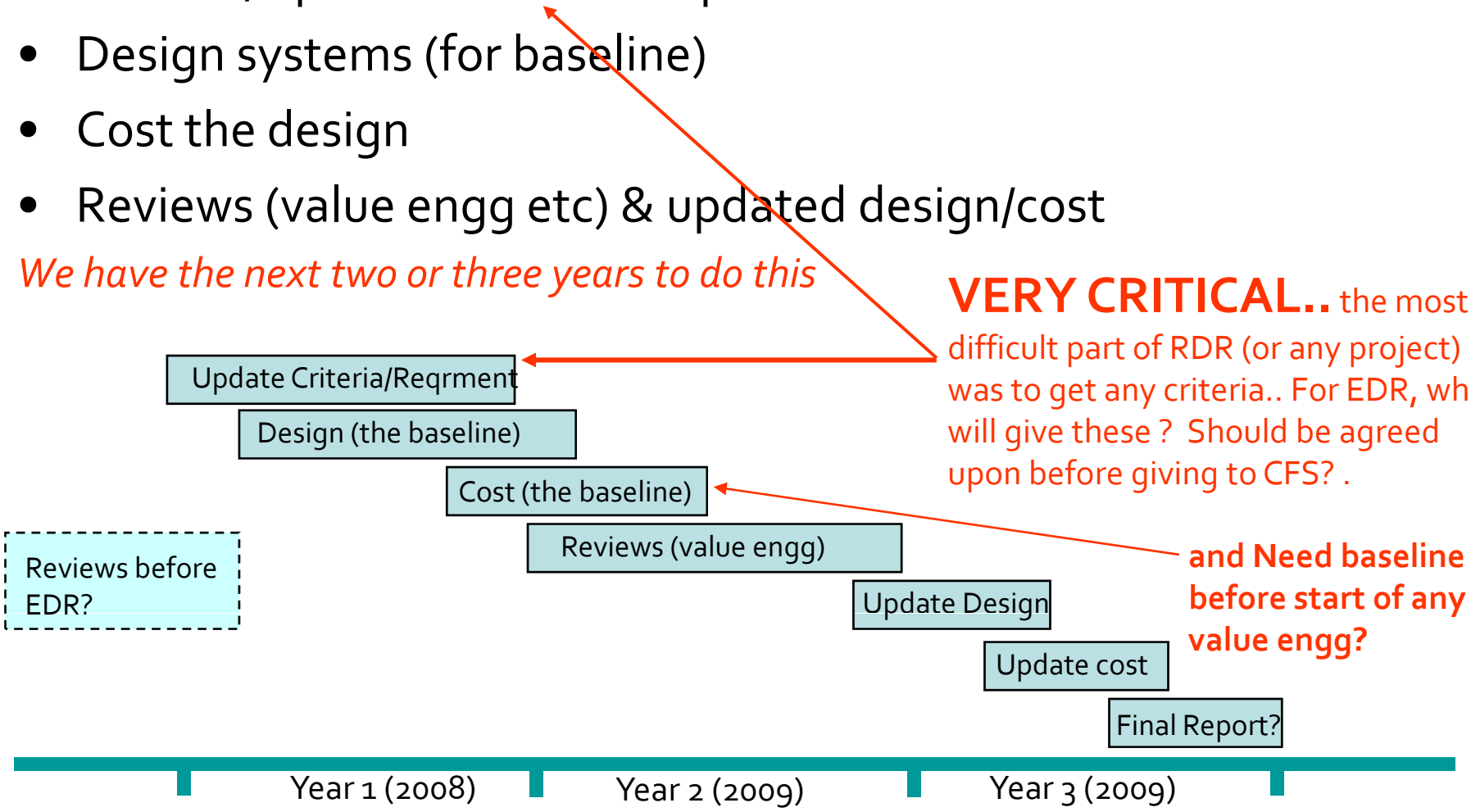
We have the next two or three years to do this



EDR Process Water- Basic Approach

- Receive/Update criteria & requirement
- Design systems (for baseline)
- Cost the design
- Reviews (value engg etc) & updated design/cost

We have the next two or three years to do this



VERY CRITICAL.. the most difficult part of RDR (or any project) was to get any criteria.. For EDR, who will give these ? Should be agreed upon before giving to CFS? .

and Need baseline before start of any value engg?

EDR Process Water - EDR Goal & deliverables?

Goals

- Work with " *??area systems? integration group???*" to get criteria updated and establish/update a preliminary conceptual design baseline
- Provide bottoms up cost estimate (not scaled)
- Provide various option studies to support the value engineering effort

Deliverables

- Conceptual design with Interfaces established
- Cost Estimate
- Other reports or other design work needed for the EDR

…need concurrence

EDR Process Water – Some Items for value engg/optimization

Some of the items initially discussed & considered during RDR. Some can be revisited during EDR

- Reduction of Thermal Load
- Make all chiller aircooled
  - End up with combination of water cooled for large chiller and aircooled for smaller chiller (considered in cost)
- Reduce LCW Skids
  - From 1 skid per rf, 1 skid per 2 rf to 1 skid per4rf
- Totally Remove Chilled Water
  - Racks still need cooler water
- Reduce Chilled Water Usage
- Cooler Supply temperature
- Cost savings due to Industrialization of Lcw Skids
- Piping Materials, why stainless, why not PVC?
- Approach HX temperature, closer approach vs HX cost
- Size main pipe in tunnel at Lower velocities
- Minimize power usage
- Eliminate HX and Pump in cavern
  - Was looked into, but was not a cost driver, and will create high pressure water system in tunnel
- Use one large LCW HX distribution from each cavern shaft
- Use of Non-LCW water/ Reduce LCW
- Increase Delta T

History and description of these items are available on CFS companion document…

EDR Process Water – Some Items for value engg/optimization

LCW vs Non-LCW (History)

Around Nov 2006, there was a push of minimizing usage of LCW in ML RF system (pushback), this lead to a criteria that resulted to 1%LCWand 99% Non-LCW in ML RF heat table, that was given to CFS as criteria to be used, even though there were a number of people who were opposed to it.

Just a few days before the deadline for the cost (Dec 4), we did a very quick cost evaluation but eventually decided on using 100% LCW model as the cost basis for RDR (*see next few slides for reasons*)

Can be revisited during EDR value engg, when LCW design is mature, and IF the pro/cons amongst users (not cfs) is resolved.

EDR Process Water – Some Items for value engg/optimization

NOV 27a 2006

WATER AND AIR HEAT LOAD (Load Pushback Version) and 9-8-9 ML

MAIN LINAC - ELECTRON & POSITRON

Components	Quantity Per 36m	Location	Total Heat Load (KW)	Average Heat Load (KW)	To ~~Dirty Water~~ Non-LCW: Heat Load to Water (KW)	Supply Temp (variation) (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C	To Low Conductivity Water: Heat Load to Water (KW)	Supply Temp (variation) (C)	Delta Temperature (C delta)	Water Flow (l / min)	Maximum Allowable Pressure (Bar)	Typical (water) pressure drop Bar	Acceptable Temp Variation delta C
RF Components																		
RF Charging Supply 34.5 Kv AC-8KV DC	1/36 m	Service Tunnel	4.0	4.0	2.8	40	40	1.17	18	8	10							
Switching power supply 4kV 50kW	1/36 m		7.5	7.5	4.5	35	13.6	7.6	13	8	10							
Modulator	1/36 m	Service Tunnel	7.5	7.5	4.0				28.823			0.5						
Pulse Transformer	1/36 m	Service Tunnel	1.0	1.0	0.7													
Klystron Socket Tank / Gun	1/36 m	Service Tunnel	1.0	1.0	0.8													
Klystron Focusing Coil (Solenoid)	1/36 m	Service Tunnel	4.0	4.0	3.6													
Klystron Collector	1/36 m	Service Tunnel	58.9	47.2	45.8	*35>				2								
Klystron Body	1/36 m	Service Tunnel			0.0	*35>				5	+ - 2.5 C							
Klystron Windows	1/36 m	Service Tunnel			0.0	*35>				1								
Relay Racks (Instrument Racks)	1/36 m	Service Tunnel	10.0	10.0	0.0	N/A	N/A		N/A	N/A	None	0.0	N/A	N/A		N/A	N/A	None
Circulators, Attenuators & Dummy Lo	1/36 m	Accelerator Tunnel	42.3	34.0	32.3						+ - 2.5 C							
Waveguide	1/36 m	Accelerator Tunnel	3.9	3.9	3.5						+ - 2.5 C							
Subtotal RF unit Only			140.10	120.10														
Total RF			162.8	140.8	99.49							0.50						

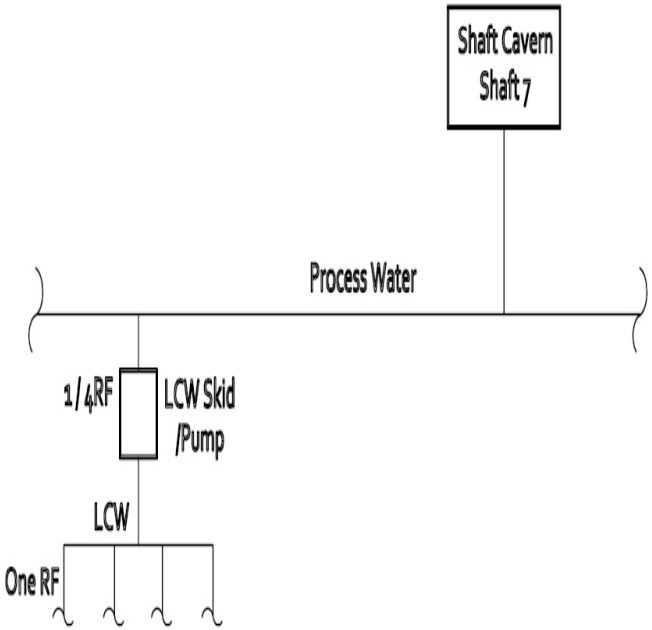
99%

1%

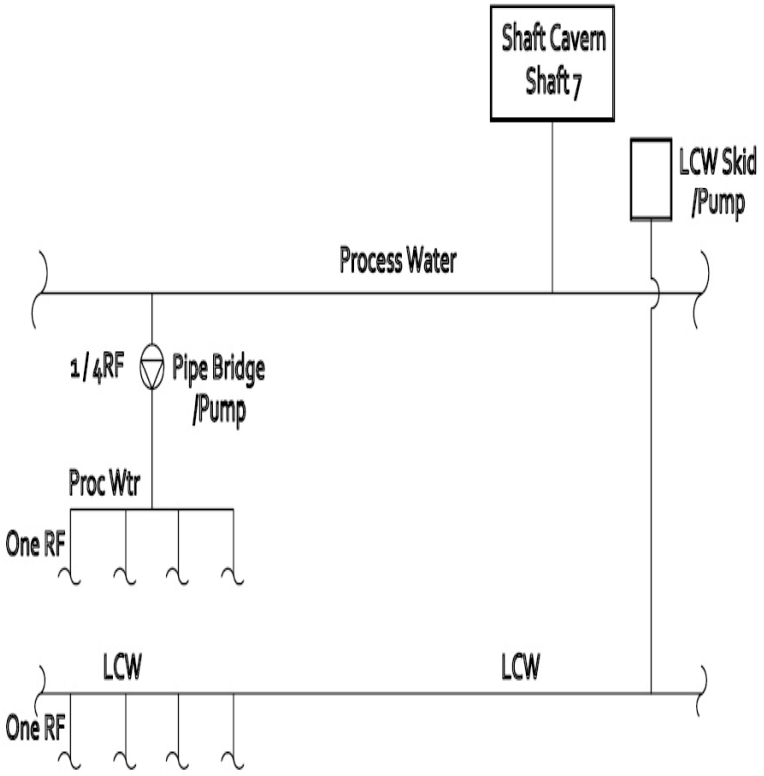
Total Heat load to Dirty Water (per RF)	**99.5 KW**	cooled by process water with rust inhibitor
Total Heat load to Chilled water (per RF)	**37.6 KW**	cooled by chilled water
Total Heat load to LCW (per RF)	**0.5 KW**	cooled by low conductivity water **1%**

EDR Process Water – Some Items for value engg/optimization

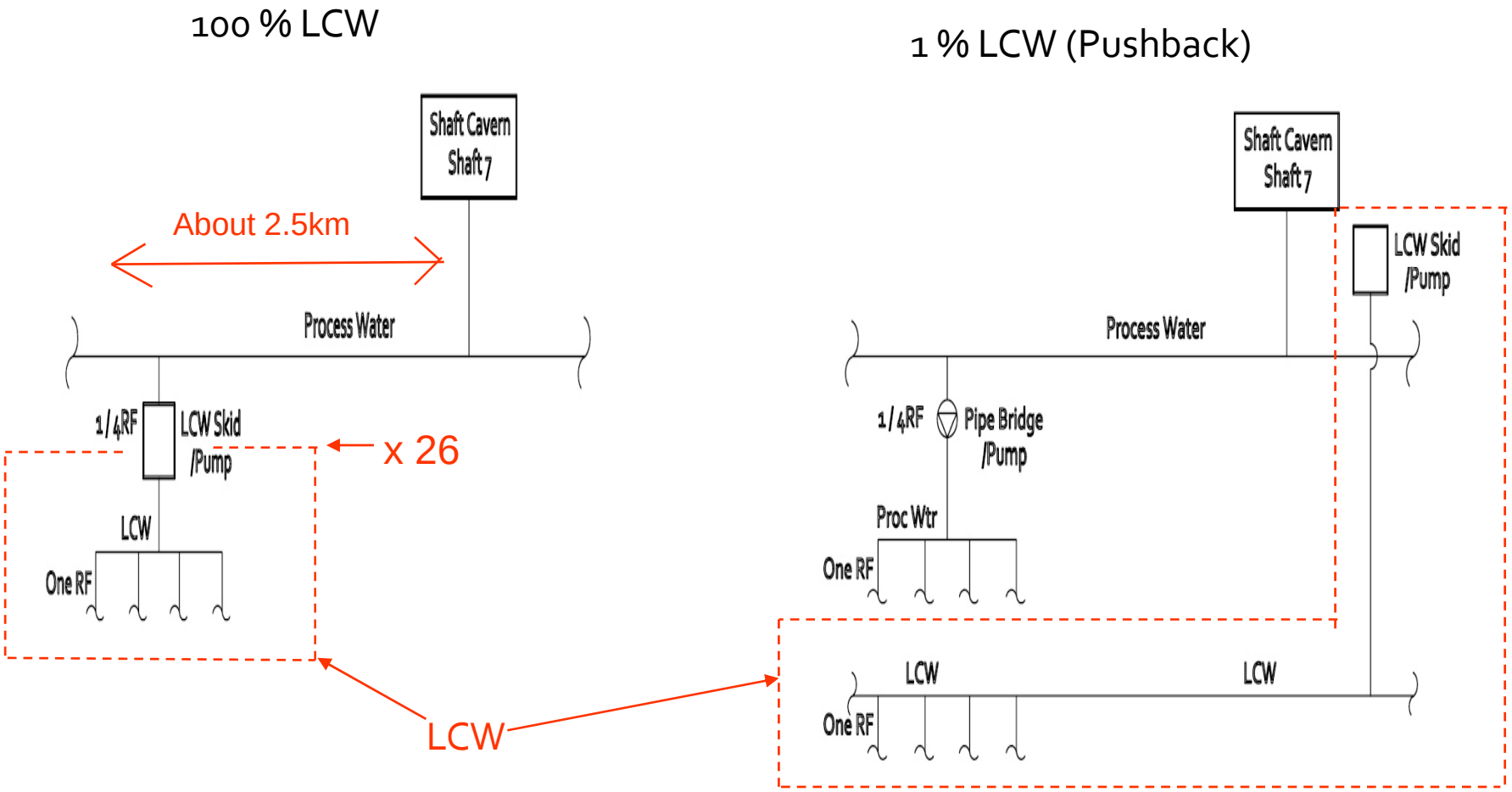
100 % LCW



1 % LCW (Pushback)



EDR Process Water – Some Items for value engg/optimization



EDR Process Water – Some Items for value engg/optimization

Impact of Pushback (1% LCW, 99% Process Water)

1	**Chilled Water related**
2	**LCW related**
3	Compress Air
4	**Process Piping**
5	Process Water Equipment (Tower/HX)
6	**Process Pumps**
7	Engg
	TOTAL

← Reduce Cost in LCW subwbs

← But Additional Cost in Process Piping subWBS

← Net only about 4% of Process Water savings

(to be revisited??)

EDR Process Water – Some Items for value engg/optimization

- High Delta T (currently used 20F delta in RDR, will likely be adjusted to higher delta T when we get more info)

  Water system I'm familiar with personally , has less than 20F delta, LHC has 18 delta T, MI LCW deltaT around 15 F delta, FNAL CUB LCW system 10 F delta, Chilled water typically under 18F delta.

  Need to look into XFEL approach where they have high delta T system by series/stacking load, to see if applicable

  will still need more info on max allowable temperature and pressure drop information on various water cooled components

  Consider limitation in the supply temperature in Illinois summer condition and the number of loops due to depth, Current LCW supply temperature is at 95 F..other affected items?(life of equipment etc)

  Need to separately look into magnets water cooling (instead of scaling) because its already at higher delta T. Water system to BDS Dump at 54F delta already considered in RDR

  Consider Keith's idea of having dedicated pump for the Klystron collector.

  Others??

Process Water Summary

- We need to spend time understanding the info and criteria that is already available, understanding the locations of watercooled components and list/pursue what's missing

  Examples,

  ML RF (pressure drop components, max allowable temperatures)

  DR, Sources, RTML,BDS,IR (need to spend the time to understand the location of components & requirements)

- There were potential items for optimization (from RDR cost reduction exercise) that can be revisited, but we need to update criteria and design for each area system first (baseline).

- The critical item is getting any updated criteria early (this is the one that will be used to develop the baseline design for each area system), and ensuring getting this from an official group, instead of getting request from various directions.

  (where to get this?, is it still by area system?? In case of disagreement/fight amongst user, who will officially decide which one to give to CFS as criteria?area system leaders? Is there some sort of a "separate group, integration maybe?" that will decide that?