भारत हेवी इलेक्ट्रिकल्स लिमिटेड
(सार्वजनिक क्षेत्र का उपक्रम)
Bharat Heavy Electricals Limited
(A Public Sector Undertaking)

पावर सेक्टर- पश्चिमी क्षेत्र Power Sector-Western Region
श्रीमोहिनी काम्पलेक्स, 345 किंग्सवे, नागपूर Shreemohini complex, 345 Kingsway Nagpur - 440 001
फोन / Phone 0712- 2858600, फैक्स FAX: 0712-2858699 www.bhelpswr.co.in
BHEL PAN: AAACB4146P

Ref: BHE/PW/PUR/WNT-DM PLANT PGTEST-U8/2402/Corg-02/Clarifications Dt: 07/04/2021

To,

ALL BIDDERS,

Sub: Corrigendum-02: Clarifications

Job: Resolution of pending technical issues and Expert/ Consulting services for DM Plant PG test at Wanakbori Extn Unit-08 Set-01 at GSECL 1X800MW project.

E- TENDER SPECIFICATION NUMBER: BHE/PW/PUR/WNT-DM PLANT PGTEST-U8/2402

Bidders to kindly take note of the following:

AA) Amendments

Sl no.	Existing Clause of VOLIA TCC	Remarks	Amendment / To be replaced as
1	Annexure 2 PROCESS DESIGN & SIZING CALCULATIONS , RESIN DS, VESSEL THK etc	Stands deleted/replaced	Revised Annexure 2 PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED). *Provided along with this Corrigendum 02*
2	Annexure 1 P&I DIAGRAM FOR DM PLANT REV 00:	Stands deleted/replaced	Revised Annexure 1 PE-V0-408-155-A001 P&I DIAGRAM FOR DM PLANT REV 04. *Provided along with this Corrigendum 02*

BB) Clarifications:

Sl no.	Bidder's query	BHEL's Clarifications
1	Please Provide Present water analysis report.	Please refer enclosed Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]. Refer page number 5 of 72. And RESIN report dt. 11.02.2020 as provided as Annexure 3 RESIN REPORT DM Plant S-15 to S-16 BHEL- Wanakbori in VOLIA TCC.
2	Please Provide Regeneration Chemicals Details and quantity.	Please refer enclosed Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]. All the information is available in process sizing calculation document

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
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BHEL PAN: AAACB4146P

Ref: BHE/PW/PUR/WNT-DM PLANT PGTEST-U8/2402/Corg-02/Clarifications Dt: 07/04/2021

3	Please Provide Regeneration Time.	Please refer enclosed Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]. All the information is available in process sizing calculation document
4	Please Provide: Pre Treatment chemical details and dosage	Please refer enclosed Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]. Refer page number 5 of 72. It is clarified water analysis.
5	Please Provide: Individual unit output between regeneration details (OBR).	Please refer enclosed Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]. All the information is available in process sizing calculation document.
	NOTE: Bidder to visit site and collect any further information.	

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All other Terms and conditions of the Tender Specification shall remain unaltered unless expressly amended by BHEL in writing. Bidders are requested to submit as a part of their offer, a copy of this corrigendum duly Digitally countersigned by the authorized signatory as a token of Bidder's unqualified acceptance of this corrigendum.

This letter is hosted as file titled "Corrigendum02Clarfications" against NIT-2402 on **BHEL GeP NIC Portal i.e. https://eprocurebhel.co.in**

BIDDERS MAY PLEASE NOTE THAT SUBJECT TENDER IS E-TENDER AND THE OFFER IS TO BE SUBMITTED ONLY IN **BHEL GeP NIC Portal i.e. https://eprocurebhel.co.in**

BIDDERS WHO HAVE ALREADY SUBMITTED THEIR OFFERS PRIOR TO ISSUANCE OF THIS CORRIGENDUM IN E-TENDER PORTAL ARE REQUIRED TO RE-SUBMIT THEIR OFFER AFTER TAKING COGNIZANCE OF THIS CORRIGENDUM.

Enclosures:

1. Revised Annexure 1 PE-V0-408-155-A001 P&I DIAGRAM FOR DM PLANT REV 04.
2. Revised Annexure 2 [PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]

Thanking you,
Yours faithfully,

AGM (Purchase)

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
(सार्वजनिक क्षेत्र का उपक्रम)
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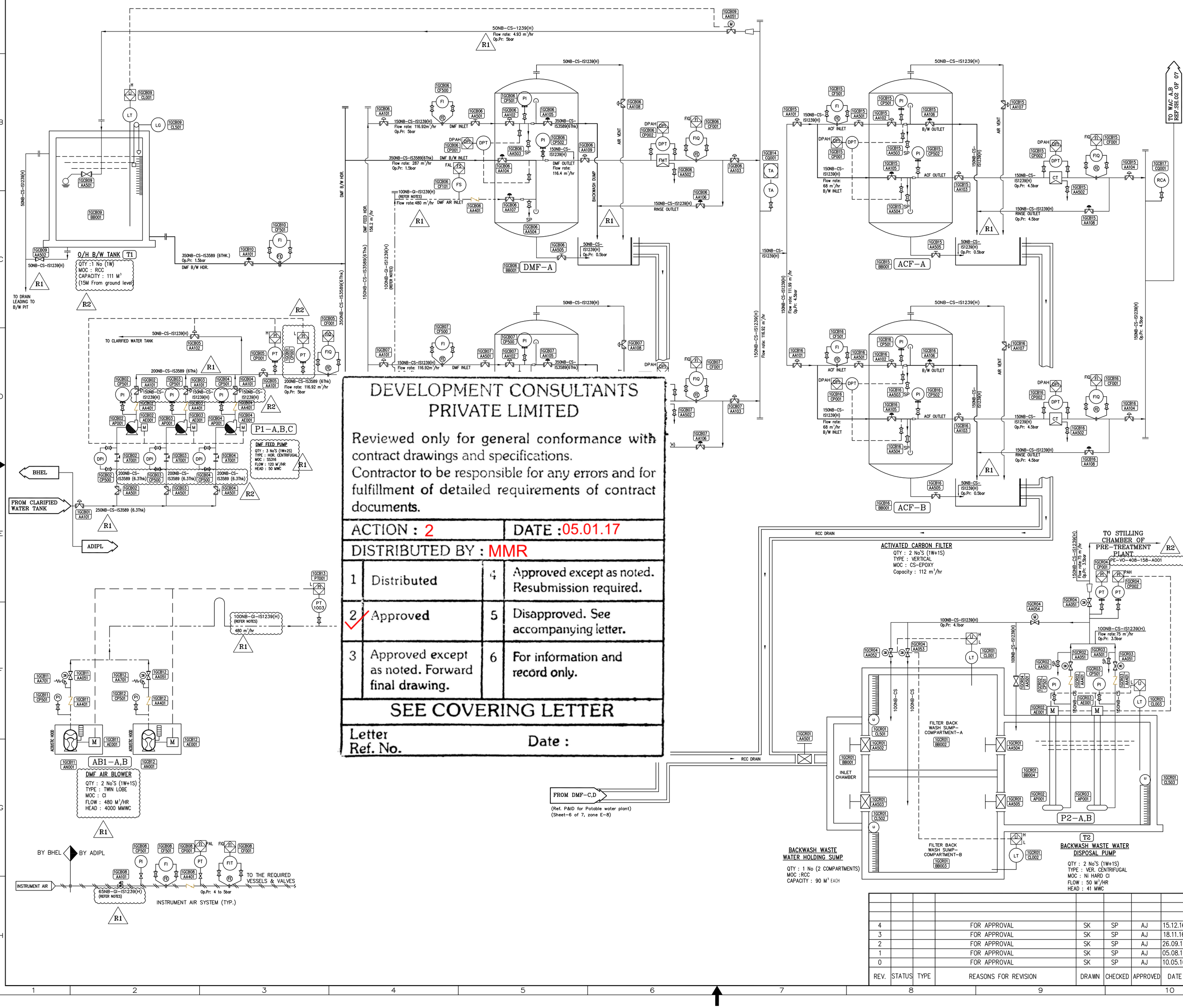
BHEL PAN: AAACB4146P

Revised Annexure 1

PE-V0-408-155-A001 P&I DIAGRAM FOR DM PLANT REV 04

DWG. PE-VO-408-153-A001 NO. REV. '3'



LIST OF EQUIPMENT

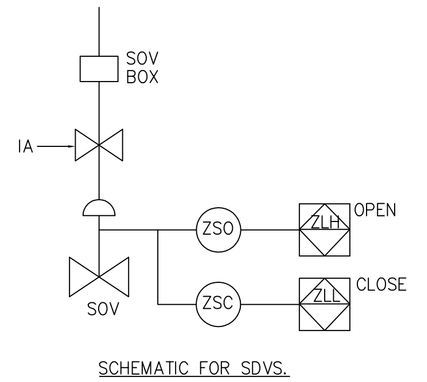
S.NO	DESCRIPTION	QUANTITY	MOC	APPROX. SIZE	KKS TAGGING
01	DMF FEED PUMP	3Nos (1W+2S)	SS316	120m³/hr@50mWC	1GCB02/03/04/AP001
02	DUAL MEDIA PRESSURE FILTER (DMF)	2Nos (1W+1S)	CSEP	ø3.9Mx2.9M Hos	1GCB06/07/BB001
03	AIR BLOWER FOR DMF	2Nos (1W+1S)	CI	480m³/hr@4000mmWC	1GCB11/12/AN001
04	OVERHEAD B/W WATER STORAGE TANK – 111 CUM.	1 No	RCC	6.1M(L)X6.1M(B) X3.0M(Ht)+0.5(FB) +0.1M(DD)	1GCB09BB001
05	BACKWASH WASTE WATER STORAGE SUMP – 90 CUM. EACH	2Nos (1W+1S)	RCC	5.5M(L)X5.5M(B) X3.0MHT+0.5(FB) +0.1M(DD)	1GCR01BB002/003
06	BACKWASH WASTE WATER DISPOSAL PUMP	2Nos (1W+1S)	Ni hard CI	50m³/hr@41mWC	1GCR02/03AP001
07	ACTIVATE CARBON FILTER (ACF)	2Nos (1W+1S)	CSEP	ø3.1Mx3.0M Hos	1GCB15BB001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	11 Nos	R4
02		AUTO DIAPHRAGM VALVE–NORMALLY OPEN	26 Nos	
03		AUTO DIAPHRAGM VALVE–NORMALLY CLOSED	15 Nos	
04	M	MOTORIZED GATE VALVE	8 Nos	
05		NON RETURN VALVE	10 Nos	
06		'Y' TYPE STRAINER	3 Nos	
07		SLUICE GATE VALVE	5 Nos	
08		PNEUMATIC GLOBE VALVE	1 No	
09		GATE VALVE–MANUAL	3 Nos	
10	M	MOTORIZED DIAPHRAGM VALVE	1 No	
11		BALL VALVE	6 Nos	

NOTES

1. ALL BUTTERFLY VALVES HAVE BEEN CHANGED TO DIAPHRAGM VALVES FROM R0 TO R1.
2. GALVANIZING AS PER IS4736 DONE ON IS1239(H) PIPES FOR AIR BLOWER LINES. END CONNECTION OF PIPES SHALL BE THREADED/FLANGED.
3. OPERATING PRESSURE HAS BEEN INCORPORATED FOR ALL LINES



SCHEMATIC FOR SDVS.

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wanakbori Thermal Power Station Extn. Unit-8

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Ph : 91-44-37171717, Fax: 91-44-37171737.
Email: sales@aquadesigns.in. Web site: www.aquadesigns.in.

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

TITLE : P&ID FOR DM–PLANT (SHEET 1 OF 7)

UNIT : | SCALE : NTS | BHEL DWG. NO. : PE-VO-408-163-A001 | REV. 04

A1 (09-96) [841 x 594]

DWG. PE-V0-408-153-A001 NO. REV. '3'

FROM ACF-A,B SHEET 1 OF 6 (zone B-10, sh. 1 of 7)

ACID FROM SAC (zone B-10)

FROM DEGASSER TRANSFER PUMP DISCHARGE HEADER (zone F-10)

SERVICE WATER REFER DWG NO: PE-DG-408-172-N003

TO WAC-A,B (zone D-1)

TO WBA-A,B (zone B-3, Sheet 3 of7)

TO AMT-A,B EJECTORS FOR REGEN. (zone D-1, sh. 4 of 7)

TO WAC-A,B EJECTORS FOR REGEN. (zone E-1)

FROM AMT-A,B SHEET 10 OF 14

WAC-A

WAC-B

WEAK ACID CATION
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CS-RL
FLOW : 111.76 m^3/hr

SAC-A

SAC-B

STRONG ACID CATION
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CS-RL
FLOW :110.78 m^3/hr

DGT-A

DGT-B

DEGASSER TOWER
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CSRL
FLOW : 110.78 M^3/HR

T3-A

T3-B

AB2-A,B,C,D

DG AIR BLOWER
QTY : 4 No'S (2W+2S)
TYPE : CENTRIFUGAL
MOC : CI / CS
FLOW : 3150 M^3/HR
HEAD : 100 MMWC

DEGASSED WATER STORAGE TANK
QTY : 2 No'S (1W+1S)
TYPE : HORIZONTAL
MOC : CSRL
CAPACITY : 185 M^3

P3-A,B,C,D

DEGASSED WATER TRANSFER PUMP
QTY : 4 No'S (2W+2S)
TYPE : HOR. CENTRIFUGAL
MOC : SS316
FLOW : 120 M^3/HR
HEAD : 38 MWC

R2

LIST OF EQUIPMENT

S.NO	DESCRIPTION	QUANTITY	MOC	APPROX.SIZE	KKS TAGGING
01	WEAK ACID CATION EXCHANGER (WAC)	2Nos(1W+1S)	CSRL	ø1.9Mx2.1M Hos	1GCF01/02BB001
02	STRONG ACID CATION EXCHANGER (SAC)	2Nos(1W+1S)	CSRL	ø1.9Mx2.4M Hos	1GCF03/04BB001
03	DEGASSER TOWER	2Nos(1W+1S)	CSRL	ø1.7Mx3.75M Hos	1GCF05/06BB001
04	DEGASSER AIR BLOWER	4Nos(2W+2S)	CI/CS	3150M^3/hr@100mmWC	1GCF9/10/11/12AN001
05	DEGASSED WATER STORAGE TANK	2Nos(1W+1S)	CSRL	ø4.8MX9.0 Hos	1GCF07/08BB001
06	DEGASSED WATER TRANSFER PUMP	4Nos(2W+2S)	SS316	120M^3/hr@45mWC	1GCF14/15/16/17AP001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	27	
02		AUTO DIAPHRAGM VALVE–NORMALLY OPEN	31	
03		AUTO DIAPHRAGM VALVE–NORMALLY CLOSED	28	
04	M	MOTORIZED GATE VALVE	04	
05		NON RETURN VALVE	11	
06		'Y' TYPE STRAINER	04	
07	S	SOLENOID VALVE	04	
08	FCV, POS	FLOW CONTROL VALVE (GLOBE VALVE)	02	

NOTES

1. LINE SIZES MODIFIED BASED ON REV–0 COMMENTS & ALSO SYSTEM REQUIREMENT.
2. GALVANIZING AS PER IS4736 DONE ON IS3589(6Thk.) PIPES FOR AIR BLOWER LINES. END CONNECTION OF PIPES SHALL BE FLANGED.
3. FLOW CONTROL VALVE SHALL BE IN BHEL SCOPE

R3

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

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CONSULTING ENGINEERS
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Aqua Designs India Pvt Limited
Office: 200 Feet Road, Kolathur, Chennai – 600 099.
Ph : 91–44–37171717, Fax: 91–44–37171737,
Email: adsed@aquadesigns.in. Web site:www.aquadesigns.in.

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

TITLE : P&ID FOR DM–PLANT (SHEET 2 OF 7)

UNIT : | SCALE : NTS | BHEL DWG. NO. : PE-V0-408-163-A001 | REV. 04

A1 (09–96) [841 x 594]

DWG. PE-V0-408-153-A001
NO.
REV. '3'

FROM DEGASSED WATER TRF. PUMP
150NB-CSRL-IS1239(H)
(zone F-10 sh. 2 of 7)

FROM CMT2-A,B SHEET 05 OF 07
(zone F-6 sh. 5 of 7)

CAUSTIC FROM SBA
(zone B-9)

WATER FROM REGEN.PUMP DISCHARGE HEADER SHEET 4 OF 7
(zone F-9 sh. 4 of 7)

FROM AMT1-C SHEET 04 OF 06
(zone C-9 sh. 4 of 7)

FROM CMT2-C SHEET 05 OF 06
(zone B-6 sh. 5 of 7)

TO WBA-A,B
(zone D-1)

TO DMWST-A&B SHEET 4 OF 7
(zone E-1.)

TO N-PIT SHEET 5 OF 6
(zone G-7)

WBA-A

WBA-B

SBA-A

SBA-B

MB-A

MB-B

WEAK BASE ANION
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CS-RL
FLOW : 108.06 m³/hr

STRONG BASE ANION
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CS-RL
FLOW : 107.18 m³/hr

MIXED BED
QTY : 2 No'S (1W+1S)
TYPE : VERTICAL
MOC : CS-RL
FLOW : 106.44 m³/hr

AB3-A,B
MB & N-PIT AIR BLOWER
QTY : 2 No'S (1W+1S)
TYPE : TWIN LOBE
MOC : CI
FLOW : 450 M³/HR
HEAD : 4000 MMWC

WASTE BLEED

DRAIN DOWN PIPE

BACKWASH DOWN

150NB-SS304 SCH.40

LIST OF EQUIPMENT

S.NO	DESCRIPTION	QUANTITY	MOC	APPROX.SIZE	KKS TAGGING
01	WEAK BASE ANION EXCHANGER (WBA)	2Nos(1W+1S)	CSRL	ø1.9Mx2.1M Hos	1GCF18/19BB001
02	STRONG BASE ANION (SBA)	2Nos(1W+1S)	CSRL	ø1.9Mx3.3M Hos	1GCF20/21BB001
03	MIXEXD BED EXCHANGER (MB)	2Nos(1W+1S)	CSRL	ø1.6Mx2.4M Hos	1GCF23/24BB001
04	AIR BLOWER FOR MB & N-PIT	2Nos(1W+1S)	CI	700 m3/hr@4000 mmWC	1GCF25/26AN001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	20	
02		AUTO DIAPHRAGM VALVE– NORMALLY OPEN	25	
03		AUTO DIAPHRAGM VALVE– NORMALLY CLOSED	42	
04		MANUAL GATE VALVE	02	
05		NON RETURN VALVE	04	
06	S	SOLENOID VALVE	06	

NOTES

1. LINE SIZES MODIFIED BASED ON REV-0 COMMENTS & ALSO SYSTEM REQUIREMENT.
2. GALVANIZING AS PER IS4736 DONE ON IS1239(H) PIPES FOR AIR BLOWER LINES. END CONNECTION OF PIPES SHALL BE THREADED/FLANGED.

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

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Email: sales@aquadesigns.in. Web site: www.aquadesigns.in.

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

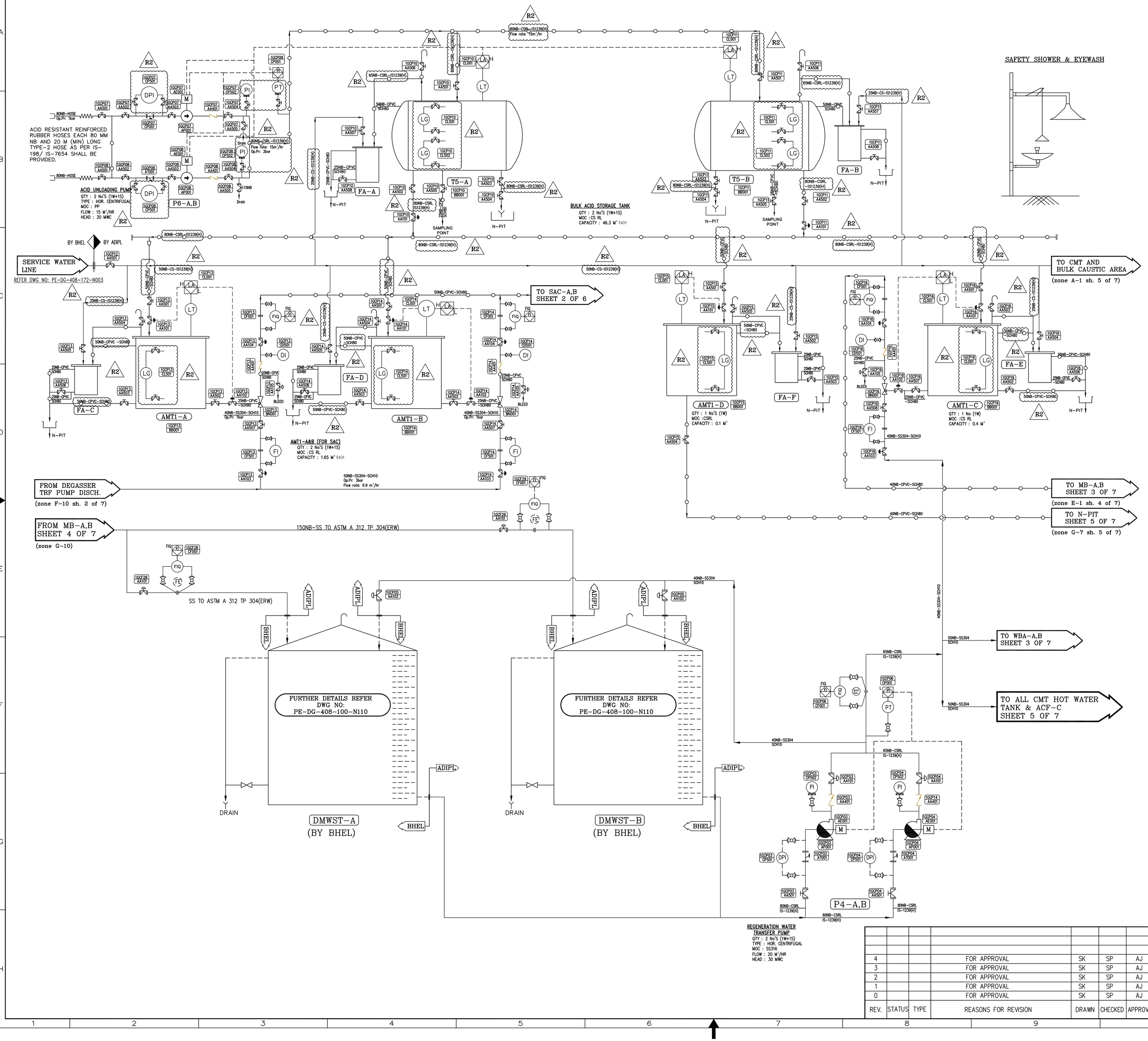
TITLE : P&ID FOR DM-PLANT (SHEET 3 OF 7)

UNIT : | SCALE : NTS | BHEL DWG. NO. : PE-V0-408-163-A001 | REV. 04

A1 (09-96) [841 x 594]

DWG. PE-V0-408-153-A001 NO.

REV. '3'



R2

LIST OF EQUIPMENT

S.NO	DESCRIPTION	QUANTITY	MOC	APPROX. SIZE	
	REGEN. WATER TRANSFER PUMP	2Nos(1W+1S)	SS316	20M³/hr@30mWC	1GCP03/04AP001
02	ACID UNLOADING PUMP	2Nos(1W+1S)	PP	15M³/hr@20mWC	1GCP03/04AP001
03	BULK ACID STORAGE TANK	2Nos(1W+1S)	CSRL	ø3.2Mx6.3Los	1GCP07/08AP001
04	ACID MEASURING TANK FOR SAC	2Nos	CSRL	ø1.3Mx1.27HTx 0.3FB+0.1m(DD)	1GCP13/14BB001
05	ACID MEASURING TANK FOR MB	1No	CSRL	ø0.8Mx0.825HTx 0.3FB+0.1M(DD)	1GCP15BB001
06	ACID MEASURING TANK FOR N-PIT	1No	CSRL	ø0.8Mx0.825HTx 0.3FB+0.1M(DD)	1GCP16BB001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	55	
02		AUTO DIAPHRAGM VALVE– NORMALLY OPEN	09	
03		AUTO DIAPHRAGM VALVE– NORMALLY CLOSED	15	
04		NON RETURN VALVE	07	
05		'Y' TYPE STRAINER	02	

NOTES

1. LINE SIZES MODIFIED BASED ON REV-0 COMMENTS & ALSO SYSTEM REQUIREMENT.

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

GSECL — GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
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	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

TITLE : P&ID FOR DM-PLANT (SHEET 4 OF 7)

UNIT : | SCALE : NTS | BHEL DWG. NO. : PE-V0-408-163-A001 | REV. 04

A1 (09-96) [841 x 594]

DWG. PE-V0-408-153-A001 NO. REV. '3'

R1

SERVICE WATER

REFER DWG NO: PE-DG-408-172-N003

R2

50NB-CS-IS1239(H)

SERVICE WATER

50NB-SS304-SCH10

DM WATER

CAUSTIC

ACF-C OUTLET

ACF-C

ACF FOR CAUSTIC

QTY : 1 No (1W)
MOC :CS RL
CAPACITY : 10 M³/Hr

DRAIN

CAUSTIC RECIR. PUMP

QTY : 2 No'S (1W+1S)
TYPE : HOR. CENTRIFUGAL
MOC : SS316
FLOW : 10 M³/HR
HEAD : 20 MWC

P8-A,B

Flow rate, 10 m³/hr
Op.Pr: 2bar

TO MB-A,B
SHEET 3 OF 6

CMT2-C

CMT2-C (FOR MB)
QTY : 1 No (1W)
MOC :CS RL
CAPACITY : 0.4 M³

CMT2-D

CMT2-D (FOR N-PIT)
QTY : 1 No (1W)
MOC :CS RL
CAPACITY : 0.1 M³

N-PIT

ALKALI BRINE SOL. PREP. TANK

QTY : 1 No (1W)
MOC :CS RL
CAPACITY : 16 M³

T7

HOT WATER TANK

QTY : 1 No (1W)
MOC : SS316
CAPACITY : 9.6 M³

T8

TO N-PIT

FROM REGEN. WATER TRANSFER PUMPS (SHEET 4 OF 7)

32NB-CPVC-SCH80
Flow rate: 2.4 m³/hr
Op.Pr: 2.5bar

HW

ALKALI RESISTANT REINFORCED RUBBER HOSES EACH 50 NB HB AND 20 M (MIN) LONG TYPE-2 HOSE AS PER IS- 108 / IS- 7654 SHALL BE PROVIDED.

P6-A,B

CAUSTIC UNLOADING PUMP

QTY : 2 No'S (1W+1S)
TYPE : HOR. CENTRIFUGAL
MOC : SS316
FLOW : 15 M³/HR
HEAD : 20 MWC

T6-A

T6-B

CO2 ABSORBER

BULK CAUSTIC STORAGE TANK

QTY : 2 No'S (1W+1S)
MOC :CS RL
CAPACITY : 141 M³

SAMPLING POINT

CAUSTIC BY GTRAVITY

CMT2-A

CMT2-B

CMT-1&2 (FOR SBA)

QTY : 2 No'S (1W+1S)
MOC :CS RL
CAPACITY : 0.9 M³

BRINE SOLN.

TO SBA-A,B
SHEET 3 OF 6

Flow rate: 7.1 m³/hr
Op.Pr: 2bar

40NB-CPVC-SCH80
Flow rate: 2.4 m³/hr
Op.Pr: 2.5bar

TO CENTRAL MONITORING BASIN/ GUARD POND

REFER DWG NO: PE-V0-408-164-A001

150NB-MSRL-IS1239(H)
Flow rate: 40 m³/hr
Op.Pr: 4.8bar

NEU.EFF. DISPOSAL PUMP

QTY : 4 No'S (2W+2S)
TYPE : HOR. CENTRIFUGAL
MOC : SS316
FLOW : 40 M³/HR
HEAD : 48 MWC

P5-A,B,C,D

RE-CIRCULATION

FOOT VALVE

T-4 (N-PIT)

N-PIT

QTY : 2 No'S (1W+1S)
MOC :RCC
CAPACITY : 145 M³ EACH

(zone G-7 sh. 2 of 7)
FROM MB & N-PIT AIR BLOWER SH. 3 OF 6

FROM AMT1-D
SHEET 4 OF 6
(zone E-7 sh. 3 of 7)

LIST OF EQUIPMENT R2

S.NO	DESCRIPTION	QUANTITY	MOC	APP.SIZE	KKS TAGGING
01	CAUSTIC UNLOADING PUMP	2Nos(1W+1S)	SS316	15M³/hr@20mWC	1GCP18/AP001
02	BULK CAUSTIC STORAGE TANK	2Nos(1W+1S)	CS RL	ø2.3Mx4.2M Los	1GCP19/BB001
03	CAUSTIC MEASURING TANK FOR SBA	2Nos	CS RL	ø1.1Mx1.3MHt +0.3FB+0.1M(DD)	1GCP19/BB001
04	CAUSTIC MEASURING TANK FOR MB	2Nos	CS RL	ø0.8Mx0.825MHt +0.3FB+0.1M(DD)	1GCP27/BB001
05	CAUSTIC MEASURING TANK FOR N-PIT	2Nos	CS RL	ø0.5Mx0.625MHt +0.3FB+0.1M(DD)	1GCP26/BB001
06	ACTIVATE CARBON FILTER FOR ALKALI	2Nos	CSEP	ø1.0Mx2.7M Hos	1GCP28/BB001
07	ALKALI BRINE SOLUTION PREPARATION TANK	2Nos	CS RL	ø3.0Mx3.6MHT +0.3FB+0.1M(DD)	1GCP25/BB001
08	DILUTION WATER HEATER FOR ALKALI(HOT WATER TANK)	2Nos	SS316	ø2.2Mx2.6M Hos	1GCP24/BB001
09	NEUTRALIZATION PIT – 145 CUM. EACH	2Compartment (1W+1S)	RCC	8.0M(L)x8.0M(W)x2.5HT +0.5FB+0.1M(DD)	1GCP07/BB001
10	NEUTRALIZATION EFFLUENT DISPOSAL PUMPS	4Nos(2W+2S)	SS316	40M³/hr@31mWC	1GCR11/AP001
11	CAUSTIC TRANSFER CUM RE CIRCULATION PUMP	2Nos(1W+1S)	SS316	10M³/hr@20mWC	1GCP29&30/AP001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	73	
02		AUTO DIAPHRAGM VALVE– NORMALLY OPEN	14	
03		AUTO DIAPHRAGM VALVE– NORMALLY CLOSED	48	
04		NON RETURN VALVE	16	
05		'Y' TYPE STRAINER	04	
06		SLUICE GATE VALVE	02	
07		BALL VALVE	08	

NOTES

1. LINE SIZES MODIFIED BASED ON REV–0 COMMENTS & ALSO SYSTEM REQUIREMENT.

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wanakbori Thermal Power Station Extn. Unit–8

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

BHARAT HEAVY ELECTRICALS LTD.

Aqua Designs India Pvt Limited
Office: 200 Feet Road, Kasthuri, Chennai – 600 099.
Ph : 91–44–37171717; Fax: 91–44–37171737,
Email: sales@aquadesigns.in. Web site: www.aquadesigns.in

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

TITLE :
P&ID FOR DM–PLANT (SHEET 5 OF 7)

UNIT :

SCALE : NTS

BHEL DWG. NO. : PE–V0–408–163–A001

REV. 04

A1 (09–06) [841 x 594]

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wrankdori Thermal Power Station Extn. Unit-8

DEVELOPMENT CONSULTANTS PVT. LTD.
CONSULTING ENGINEERS
KOLKATA · MUMBAI · CHENNAI · NEW DELHI

BHARAT HEAVY ELECTRICALS LTD.

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

Aqua Designs India Pvt Limited
Office: 203 Tej Bhavan, Kasturba Chowk - 400 058.
Ph : 91-44-37173173, Fax: 91-44-37173727.
Email: aquadesign@aquadesigns.in Web site: www.aquadesigns.in

TITLE : P&ID FOR DM-PLANT (SHEET 6 OF 7)

SCALE : NTS
BHEL DWG. NO. : PE-V0-408-153-A001
UNIT :
REV. 04

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
0			FOR APPROVAL	SK	SP	AJ	10.05.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
4			FOR APPROVAL	SK	SP	AJ	15.12.16

LIST OF EQUIPMENT

R2

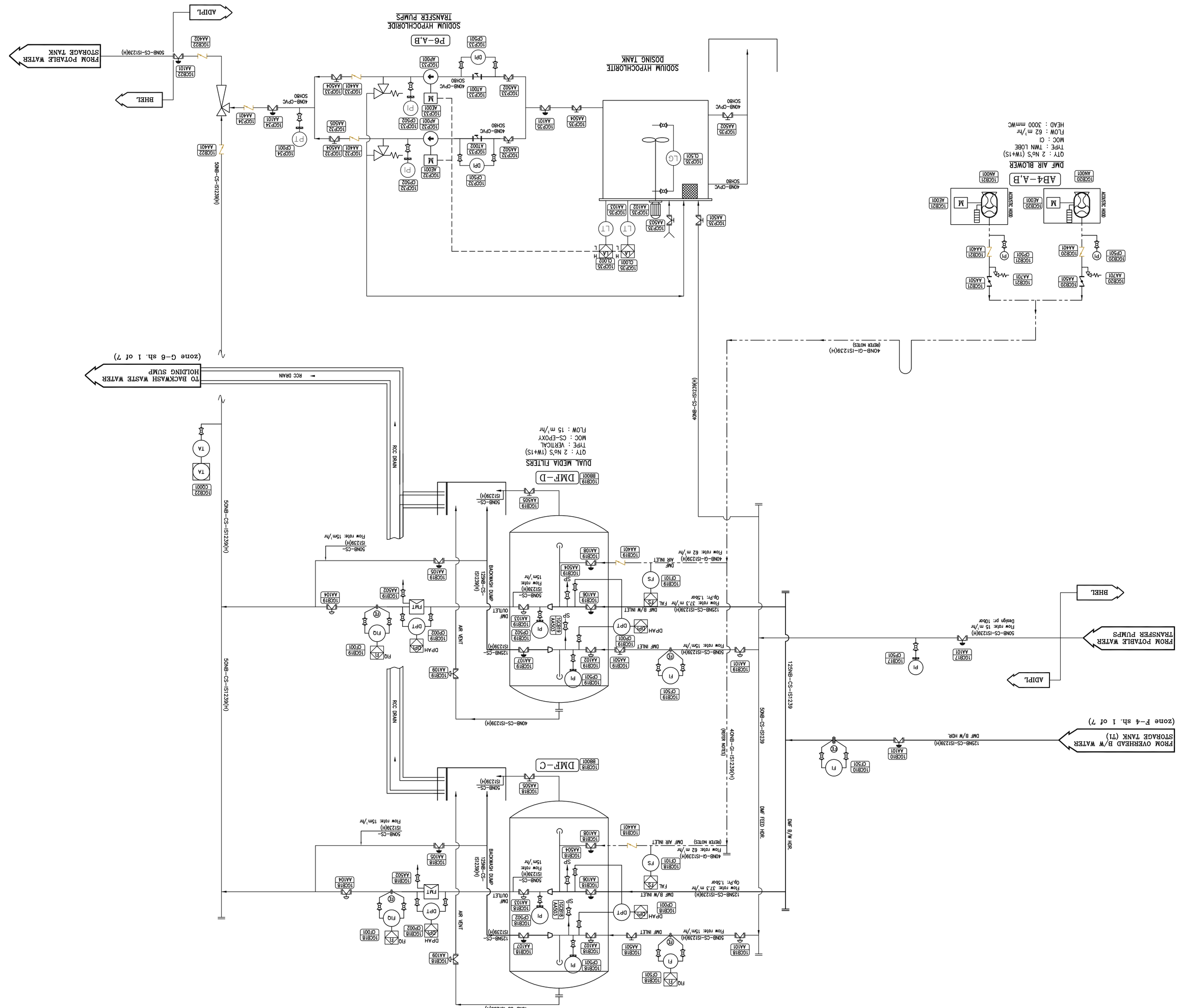
S.NO	DESCRIPTION	QUANTITY	MOC	APPROX. SIZE	KKS TAGGING
01	DUAL MEDIA PRESSURE FILTER (DMF)	2Nos (1W+1S)	CSEP	ø1.44x2.7Hos	1GCB18/19BB001
02	AIR BLOWER FOR DMF	2Nos (1W+1S)	CI	{62m³/hr@4000mmwc}	1GCB20/21AN001
03	SODIUM HYPO CHLORIDE DOSING TANK	1 No	CSRL	ø0.5Mx0.625Ht+0.3FB +0.1M(DD)	1GCB31BB001
04	SODIUM HYPO CHLORIDE TRANSFER PUMPS	2Nos (1W+1S)	CI	0-4LPH	1GCB32/33AP001

SYMBOLS FOR MECHANICAL ITEMS

SL.NO	SYMBOLS	VALVES	QTY	REMARKS
01		MANUAL DIAPHRAGM VALVE	12 Nos	
02		AUTO DIAPHRAGM VALVE– NORMALLY CLOSED	13 Nos	
03		AUTO DIAPHRAGM VALVE– NORMALLY OPEN	10 Nos	
04		NON RETURN VALVE	09 Nos	
05		'Y' TYPE STRAINER	2 Nos	
06		BALL VALVE	2 NO	
07	L/I	BUTTERFLY VALVE	2 NO	

NOTES

1. LINE SIZES MODIFIED BASED ON REV-0 COMMENTS & ALSO SYSTEM REQUIREMENT.
2. GALVANIZING AS PER IS4736 DONE ON IS1239(H) PIPES FOR AIR BLOWER LINES. END CONNECTION OF PIPES SHALL BE THREADED/FLANGED.



DWG. PE-V0-408-153-A001 NO.	REV. '3'

DWG. PE-V0-408-153-A001 NO. REV. '3'

EQUIPMENT

- CENTRIFUGAL PUMP
- VERTICAL CENTRIFUGAL PUMP
- HORIZONTAL CENTRIFUGAL PUMP
- AIR BLOWER (TWIN LOBE)
- AIR BLOWER (CENTRIFUGAL)
- VERTICAL STORAGE TANK
- HORIZONTAL STORAGE TANK
- PRESSURE VESSEL
- DEGASSER
- RESIN TRAP (RT)
- FILTER MEDIA TRAP (FMT)
- EJECTOR
- FUME ABSORBER
- CO_2 ABSORBER
- TANK – TOP CLOSED
- TANK – TOP OPEN

VALVES & FITTINGS

- MANUAL SLUICE GATE
- MANUAL GATE VALVE
- MOTORIZED GATE VALVE
- BALL VALVE
- SOLENOID VALVE
- MANUAL BUTTERFLY VALVE – FLANGED
- NON RETURN VALVE
- MANUAL DIAPHRAGM VALVE
- RELIEF VALVE
- FLOAT OPERATED VALVE
- PNEU. ACTUATED BFV NORMALLY OPEN
- MOTORISED VALVE (INCHING)
- FLOW CONTROL VALVE (GLOBE VALVE) (FCV, R4, POS)
- PNEU. ACTUATED DIAPHRAGM VALVE NORMALLY OPEN
- PNEU. ACTUATED DIAPHRAGM VALVE NORMALLY CLOSE
- DAMPER VALVE
- ECCCENTRIC REDUCER
- CONCENTRIC REDUCER
- FLANGED JOINT
- BLIND FLANGE
- STRAINER
- 'Y' TYPE STRAINER
- PUMP FOOT VALVE

ACCESSORIES

- MOTOR DRIVEN MIXER
- MANUAL MIXER
- DRAIN TO WASTE
- VENT
- MOTOR OPERATED
- PNEUMATIC ACTUATOR
- ORIFICE PLATE
- HEATING ELEMENT
- CHEMICAL SEALED DIAPHRAGM

PIPE LINES

- FLOW LINE
- EXISTING LINE / BY OTHERS
- INSTRUMENT AIR LINE
- AIR LINE
- DRAIN LINE TO NEUTRALISING PIT
- ACID LINE
- CAUSTIC LINE
- CONTROL SIGNAL

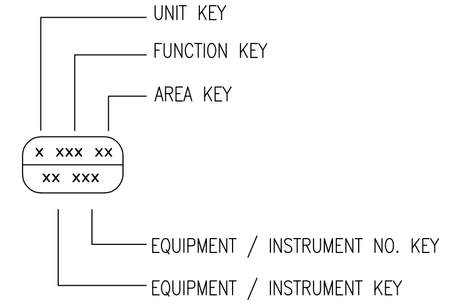
COMMON

W – WORKING
S – STAND BY
(S) – SAMPLE

INSTRUMENT IDENTIFICATION

AR – ANALYTICAL RECORDER
H – ALARM HIGH
HH – ALARM HIGH HIGH
L – ALARM LOW
LL – ALARM LOW LOW
TW – THERMO WELL
TE – TEMPERATURE ELEMENT
TG – TEMPERATURE GAUGE
TA – TURBIDITY ANALYZER
TIT – TEMPERATURE INDICATING TRANSMITTER
PG – PRESSURE GAUGE
PS – PRESSURE SWITCH
PIT – PRESSURE INDICATING TRANSMITTER
PA – PRESSURE ALARM
AE – ANALYZER ELEMENT
AIT – ANALYZER INDICATING TRANSMITTER
AI – ANALYSER INDICATOR
AA – ANALYSER ALARM
FI – FLOW INDICATOR
FE – FLOW ELEMENT
FS – FLOW SWITCH
FA – FLOW ALARM
FIT – FLOW INDICATING TRANSMITTER
FIQ – FLOW INDICATING TOTALISER
DPI – DIFFERENTIAL PRESSURE INDICATOR
DPS – DIFFERENTIAL PRESSURE SWITCH
DPIT – DIFFERENTIAL PRESSURE INDICATING TRANSMITTER
DPA – DIFFERENTIAL PRESSURE ALARM
LS – LEVEL SWITCH
LG – LEVEL GAUGE
LIT – LEVEL INDICATING TRANSMITTER
LA – LEVEL ALARM
DI – DENSITY INDICATOR
TUR – TURBIDITY
ORP – OXIDATION REDUCTION POTENTIAL
SDI – SILT DENSITY INDEX
COND – CONDUCTIVITY
pH – pH
RCA – RESIDUAL CHLORINE ANALYZER
SiA – SILICA ANALYZER
Na – SODIUM ANALYZER
CE – CONDUCTIVITY ELEMENT
CT – CONDUCTIVITY TRANSMITTER
CC – CONDUCTIVITY COMPARATOR

KKS CODING SYSTEM



UNIT KEY

1 – FIRST UNIT

FUNCTION KEY

GCB – DMF & ACF
GCF – WAC TO MB
GCP – REGENERATION & FLUSHING
GCR – RESIDUAL REMOVAL & NEUTRALIZATION

EQUIPMENT/ INST. KEY

MECHANICAL :

AP – PUMPS
AN – BLOWERS
AA – VALVES
AT – FILTERING ELEMENT
AM – MIXERS
BB – VESSELS AND STORAGE TANKS
BN – EJECTOR

ELECT, C&I :

AE – MOTORS
AH – HEATERS
CF – FLOW MEASUREMENT
CP – PRESSURE MEASUREMENT
CT – TEMPERATURE MEASUREMENT
CQ – ANALYTICAL MEASUREMENT
CL – LEVEL MEASUREMENT
CD – DENSITY MEASUREMENT
PD – DIFF. PR. MEASUREMENT

EQUIPMENT/INST. NO. KEY

MECHANICAL :

001 TO 050 EQUIPMENTS
051 TO 099 MOTORISED VALVE
101 TO 150 PNEU. ACTUATED VALVES
201 TO 299 SOLENOID OPERATED VALVES
401 TO 499 NON RETURN VALVES
501 TO 599 MANUAL VALVES
701 TO 799 PR. RELIEF VALVES

ELECT, C&I :

001 TO 099 ANALOG INSTRUMENTS – REMOTE
101 TO 199 PROCESS SWITCHES
501 TO 599 PROCESS INDICATORS – LOCAL

MATERIAL OF CONSTRUCTION FOR PIPING

S.NO	SERVICE	MATERIAL
01	CLARIFIED WATER, FILTERED WATER, SERVICE WATER, BACK WASH WASTE WATER, NON CORROSIVE WASTE WATER	CARBON STEEL PIPE TO IS1239 PART–I(H) GRADE FOR SIZES UP TO 150NB & IS3589 FOR SIZES 200NB & ABOVE
02	HYDROCHLORIC ACID (AT ALL CONCENTRATION)	RUBBER LINED PIPE CARBON STEEL PIPE TO IS1239 PART–I(H) GRADE FOR SIZES ABOVE 50NB. FOR SIZES 50NB & BELOW IT CPVC SCH80
03	DE–CATIONISED WATER, DEGASSED WATER & DE–MINERALISED WATER	RUBBER LINED PIPE CARBON STEEL PIPE TO IS1239 PART–I(H) GRADE FOR SIZES UP TO 150NB & IS3589 FOR SIZES 200NB & ABOVE
04	SODIUM HYDROXIDE (AT ALL CONCENTRATION)	RUBBER LINED PIPE CARBON STEEL PIPE TO IS1239 PART–I(H) GRADE FOR SIZES ABOVE 50NB. FOR SIZES 50NB & BELOW IT SS304 SCH10
05	NEUTRALIZED EFFLUENT	RUBBER LINED PIPE CARBON STEEL PIPE TO IS1239 PART–I(H) GRADE.
06	POTABLE WATER, SERVICE AIR, INSTRUMENT AIR	GALVANIZING AS PER IS4736 DONE ON CARBON STEEL PIPE TO IS1239(H) GRADE.

NOTE –1: FOR DEMINERALISED WATER, STAINLESS STEEL SHALL BE USED FOR SIZES OF 50MM NB AND BELOW.
NOTE – 2: FOR SMALL DIAMETER PIPE (<=50NB), WHERE RUBBER LINING IS DIFFICULT, CPVC PN 10 SHALL BE USED FOR HYDROCHLORIC ACID AND STAINLESS STEEL PIPE INSTEAD OF RUBBER LINED STEEL PIPE SHALL BE USED FOR OTHER SERVICES.

NOTES

1. ALL VALVES IN THE INLET, OUTLET, BACKWASH, REGENERATION AND RINSE OF EACH FILTER, ION EXCHANGE UNITS WILL BE PNEUMATICALLY OPERATED.
2. ALL THE LINES ARE INDICATED WITH DESIGN PRESSURE IN REV–01

REV.	STATUS	TYPE	REASONS FOR REVISION	DRAWN	CHECKED	APPROVED	DATE
4			FOR APPROVAL	SK	SP	AJ	15.12.16
3			FOR APPROVAL	SK	SP	AJ	18.11.16
2			FOR APPROVAL	SK	SP	AJ	26.09.16
1			FOR APPROVAL	SK	SP	AJ	05.08.16
0			FOR APPROVAL	SK	SP	AJ	10.05.16

GUJARAT STATE ELECTRICITY CORPORATION LIMITED
VADODARA, GUJARAT
1x800 MW Wanakbori Thermal Power Station Extn. Unit–8

DEVELOPMENT CONSULTANTS PVT. LTD.
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BHARAT HEAVY ELECTRICALS LTD.

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Email: sales@aquadesigns.in. Web site:www.aquadesigns.in.

	NAME	SIGN	DATE
DRN.	SK		10.05.16
CHD.	SP		10.05.16
APPD.	AJ		10.05.16

TITLE : P&ID FOR DM–PLANT (SHEET 7 OF 7)

UNIT : | SCALE : NTS | BHEL DWG. NO. : PE–V0–408–163–A001 | REV. 04

A1 (09–96) [841 x 594]

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
(सार्वजनिक क्षेत्र का उपक्रम)
Bharat Heavy Electricals Limited
(A Public Sector Undertaking)

पावर सेक्टर- पश्चिमी क्षेत्र Power Sector-Western Region
श्रीमोहिनी काम्पलेक्स, 345 किंग्सवे, नागपूर Shreemohini complex, 345 Kingsway Nagpur - 440 001
फोन / Phone 0712- 2858600, फैक्स FAX: 0712-2858699 www.bhelpswr.co.in
BHEL PAN: AAACB4146P

Revised Annexure 2

[PE-V0-408-163-A003 (PROCESS SIZING CALCULATION)-REV-5 (CUST APPROVED)]

CLIENT

GUJARAT STATE ELECTRICITY CORPORATION LTD

PROCESS DESIGN & SIZING CALCULATIONS , RESIN DATASHEETS, VESSEL AND TANK THICKNESS& PRESSURE DROP CALCULATIONS FOR DM PLANT – 2 X 105 m3/hr AND WATER SYSTEM – 2 x15 M3/HR

DEVELOPMENT CONSULTANTS PRIVATE LIMITED

Reviewed only for general conformance with contract drawings and specifications.
Contractor to be responsible for any errors and for fulfillment of detailed requirements of contract documents.

ACTION : 2	DATE :24.11.16
DISTRIBUTED BY : TKD/AD/JRC/BD	

1	Distributed	4	Approved except as noted. Resubmission required.
2 ✓	Approved	5	Disapproved. See accompanying letter.
3	Approved except as noted. Forward final drawing.	6	For information and record only.

SEE COVERING LETTER

Letter Ref. No. Date :

PREPARED BY

CONTRACTOR

TITLE	**BASIC ENGINEERING PACKAGE**
OWNER	**BHEL –WANAKBORI**
CONTRACTOR	**M/s. AQUA DESIGNS INDIA PVT LTD**
PLANT	**DM PLANT ALONGWITH POTABLE WATER TREATMENT PLANT**
ADIPL JOB NO	**PLA 15001**
DOC NO	**PE-V0-408-163-A003**

REVISION STATUS

Rev. No	Issued For	Prepared By	Checked By	Approved by	Date
5	Approval	VB	PK	AJ	14.11.2016
4	Approval	VB	PK	AJ	18.10.2016
3	Approval	VB	PK	AJ	07.09.2016
2	Approval	VB	PK	AJ	09.08.2016
1	Approval	VB	PK	AJ	22.07.2016
0	Approval	VB	PK	AJ	10.05.2016

INDEX

Chapter 1 PROJECT INTRODUCTION

PROJECT DETAILS

a) END CLIENT – M/S. GUJARAT STATE ELECTRICITY CORPORATION LTD
b) CLIENT - M/S. BHARAT HEAVY ELECTRICALS LIMITED
c) CONTRACTOR – AQUADESIGNS INDIA PRIVATE LIMITED

The Scope of Work Includes Design, Engineering, Manufacture, fabrication, assembly, inspection & testing at Vendor's & Sub Vendor's works, painting, forwarding, supply and delivery at site including start up and commissioning spares, mandatory spares, properly packed for transportation, unloading/handling and storage at site, in site transportation, assembly, erection & Commissioning, trail run, preparation & Submission of " As built" drawings, site testing, carrying out performance guarantee tests at site and handover of DM Plant along with Potable Water Treatment Plant.

Chapter 2 PROCESS DESIGN BASIS

Water Source : Clarified Water from Pre Treatment Plant

Plant Capacity :2 x105 m3/hr

INLET WATER CHARACTERISTICS:

S.NO	PARAMETER	UNIT	VALUE
1.	Ca as CaCO3	ppm	85
2.	Mg as CaCO3	ppm	94
3.	Sodium + Potassium as CaCO3	ppm	75
4.	Hydrogen (FMA) as CaCO3	ppm	NIL
5.	Iron in Solution	ppm	0.05
	Total Cations (Except iron) as CaCO3	ppm	254
6.	Bicarbonate as CaCO3	ppm	160
7.	Carbonate as CaCO3	ppm	NIL
8.	Hydroxide as CaCO3	ppm	NIL
9.	Sulphate as CaCO3	ppm	20
10.	Chloride as CaCO3	ppm	52
11.	Nitrate as CaCO3	ppm	22
12.	Phosphate as CaCO3	ppm	NIL
13.	Fluoride as CaCO3	ppm	NIL
	Total Anions as CaCO3	ppm	254
14.	Reactive Silica as SiO2	ppm	22
15.	Colloidal Silica	ppm	NIL
16.	Conductivity at 25 °C	µS/cm	440
17.	pH value at 25 °C		7.5-8
18.	Turbidity	NTU	Not to Exceed 15

TREATED WATER QUALITY:

S.NO	PARAMETER	UNIT	VALUE
	At the outlet of MB		
1.	Total Electrolyte	ppm	0.1 (Max)
2.	Reactive SiO2	ppm	<0.01 ppm of SiO_2
3.	Iron as Fe	ppm	Nil
4.	Free CO_2	ppm	Nil
5.	Total hardness	ppm	Nil
6.	pH value at 25 ^oC		6.8-7.2
7.	Conductivity	µS/cm	<0.1 at 25 ^oC
	At the outlet of SBA		
1.	SiO_2	ppm	<0.1 ppm of SiO_2
2.	Conductivity	µS/cm	<5 at 25 ^oC
	At the outlet of Degasser Tower		
1.	CO_2	ppm	<5 as CO2 (Rev-02)
	At the outlet of SAC		
1.	Sodium	ppm as CaCO3	<1
2.	Hardness	ppm	Not Detectable
	At the outlet of DMF		
1.	TSS	ppm	<1

Chapter 3 PROCESS DESCRIPTION

The following are the major steps involved in the process.

Clarified water will be pumped from Clarified Water Reservoir (Located in pre-Treatment Plant Area) by 3 Nos (1W+2S) filter feed pumps to Dual media Filter

Dual Media Filter:

Clarified water will enter in to Dual Media Filters and Suspended Solids present in it will be removed.

Activated Carbon Filter:

Water from Dual media Filter enters the Activated Carbon Filter. Activated Carbon Filter will remove residual Chlorine present in the water.

Weak AcidCation Exchanger (WAC):

Filtered water from Activated Carbon Filter will enter in to the Weak Acid Cation Exchanger where Temporary hardness ($HCO3^-$) will be removed.

Strong Acid Cation Exchanger (SAC):

Water from WAC is passed through the Strong Acid Cation Exchange unit for the removal of Cations. Cations Ca^{++}, Mg^{++}, Na^+, $Fe^{++}$and K^+ present in water get exchanged with H^+ ions. The resin will be exchanged as per the following reactions:

<u>DURING SERVICE CYCLE</u>**:**

$CaCl2 + R – H$ ------- > $R – Ca + HCl$

$MgCl2 + R – H$ ------- > $R – Mg + HCl$

$CaSO4 + R - H$ ------- > $R - Ca + H2SO4$

$MgSO4 + R - H$ ------- > $R - Mg + H2SO4$

DURING REGENERATION CYCLE:

$R - Ca + HCl$ ------- > $R - H + CaCl2$

$R - Mg + HCl$ ------- > $R - H + MgCl2$

Treated Water from SAC that contains acids of Chloride, Sulphates and Bicarbonate, etc…. This water is then led to Degasser Tower where it enters at the top.
On exhaustion, Strong Acid Cation Exchanger unit is regenerated in Counter Current Mode with HCl in thoroughfare regeneration with WAC unit.

DEGASSER SYSTEM:

The degasser tower (DGT) is a packed column packed with PP rings. Air is forced from the bottom of the tower by centrifugal blowers, while the water flows down through the bed of PP rings. The carbonic acid present in the water splits up in to carbon dioxide gas and water.

This carbon dioxide gas is stripped off and escapes from the top of the tower. The degassed water is collected in the degassed water tank and is pumped and fed to the Weak Base Anion Unit.

In this unit the following reaction takes place.

$H2CO3$ ------- > $H2O + CO2$

WEAK BASE ANION EXCHANGE UNIT:

Degassed water from Degassed Water Storage tank is pumped to the Weak Base Anion Exchanger.Weak base anion will remove the EMA from the feed water and the treated water will be passed to SBA, the main purpose of the WBA is to reduce the load in the SBA and chemical consumption of the DM plant and it will help in maintaining the specific and surface flow rate within the range to increase the working of plant efficiency

STRONG BASE ANION:

WBA water is passed through the Strong Base Anion Exchange unit for the removal of Anions. Anions Cl^-, $SO4^{2-}$and SiO_2^{2-}present in water get exchanged with OH^- ions. The resin will be exchanged as per the following reactions:

DURING SERVICE CYCLE OF WBA & SBA:

HCl + R – OH ------- > R – Cl + H2O

H2SO4 + R – OH ------- > R – SO4 + 2H2O

DURING REGENERATION CYCLE OF WBA & SBA:

R - Cl + NaOH ------- > R – OH + NaCl

R – SO4 + NaOH ------- > R – OH + Na2SO4

On exhaustion, Strong Base Anion Exchanger unit is regenerated in Counter Current Mode with NAOH in thoroughfare regeneration with WBA unit.

Hot Water tank with electrical heating arrangement is provided for heating the power water used for regeneration of SBA. This is to ensure the regeneration at elevated temperature for complete elution of silica from resin bed.

MIXED BED UNIT:

The slippage from Strong acid cation unit & Strong base anion Unit will be treated in Mixed Bed Unit which consists of mixture of Cation& Anion resins in the same vessel for fine polishing in order to achieve the required output water quality.

On exhaustion, mixed bed unit is regenerated using HCL and NaOH.

NEUTRALIZATION PIT

Neutralization pit shall be sized for holding the total regeneration effluent of DM plant for storage and neutralization of effluent.

Chapter 4 LIST OF EQUIPMENTS

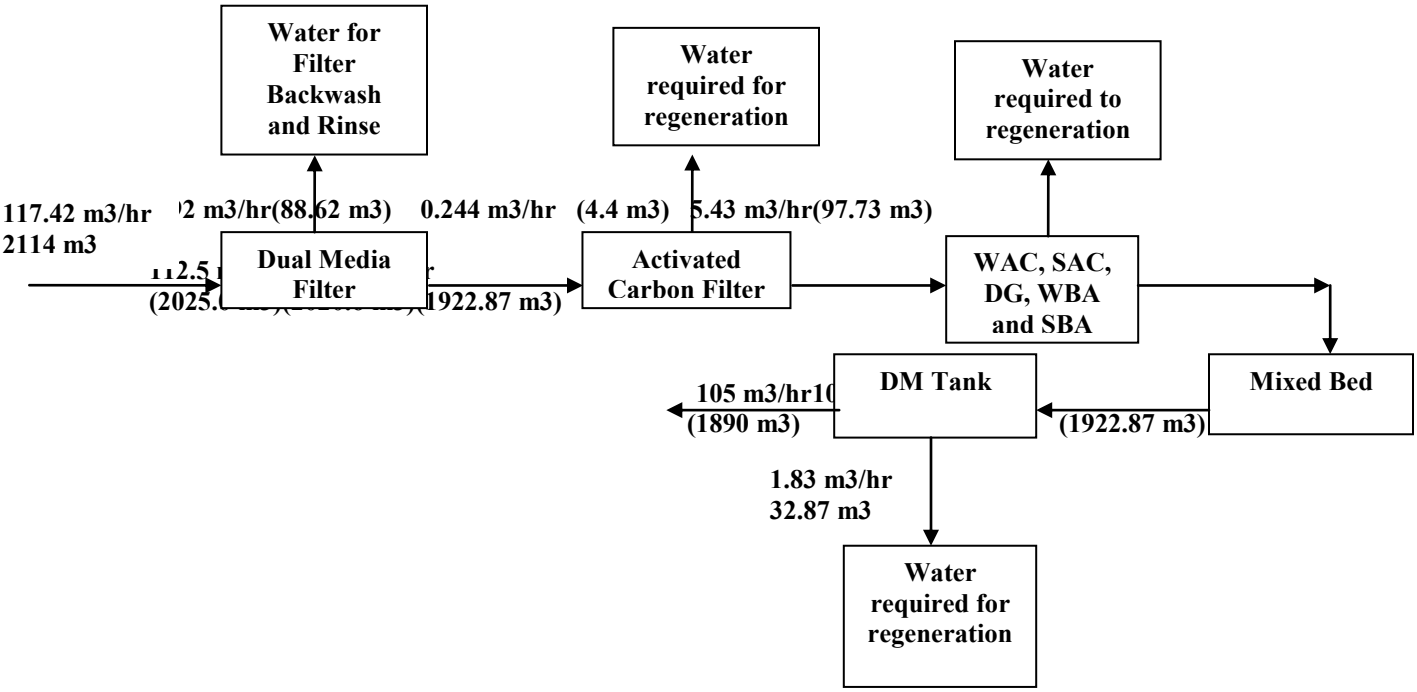
SL.NO	LIST OF EQUIPMENTS	DESCRIPTION	QUANTITY	MOC
1.	DM Feed Pump	120 m3/hr @ 50 mWC	3(1W+2S)	SS316
2.	Dual Media Pressure Filter	3.9 m Dia X 2.9 m HOS	2(1W+1S)	CSEP
3.	Air Blowers for Dual Media Pressure Filter	480 m3/hr @ 4000 mmWC	2(1W+1S)	CI
4.	Overhead Backwash Water Storage Tank	7.3 m (L) X 5.4 m (B) X 3 m (Ht) + 0.5 m (FB) + 0.1 m Dead depth(Rev-05)	1 No	RCC
5.	Activated Carbon Filter	3.1 m Dia X 3.0 m HOS	2(1W+1S)	CSEP
6.	Weak Acid Cation Exchanger	1.9 m Dia X 2.1 m HOS(Rev-03)	2(1W+1S)	CSRL
7.	Strong Acid Cation Exchanger	1.9 m Dia X 2.4 m HOS(Rev-03)	2(1W+1S)	CSRL
8.	Degasser Tower	1.7 m Dia X 3.75 m Hos (Rev-02)	2(1W+1S)	CSRL
9.	Degasser Air Blower per stream	3150 m3/hr @ 100 mmWC(Rev-02)	2(1W+1S)	CI/CS
10.	Degassed Water Storage Tank	4.8 m (Dia) X 9 m (LOS)(Rev-03)	2 Nos	CSRL
11.	Degassed Water Transfer Pump per stream	120 m3/hr @ 45mWC (Rev-03)	2(1W+1S)	SS316
12.	Weak Base Anion Exchanger	1.9 m Dia X 2.1 m Hos(Rev-03)	2(1W+1S)	CSRL
13.	Strong Base Anion Exchanger	1.9 m Dia X 3.3 m Hos(Rev-03)	2(1W+1S)	CSRL
14.	Mixed Bed Exchanger	1.6 m Dia X 2.4 m Hos(Rev-03)	2(1W+1S)	CSRL
15.	Air Blower common for Mixed Bed	700 m3/hr @ 4000 mmWC(Rev-02)	2(1W+1S)	CI

	&Neutralization Pit			
16.	Regeneration Water Transfer Pump	20 m3/hr @ 30mWC(Rev-02)	2(1W+1S)	SS316
17.	Acid Unloading Pump	15 m3/hr @ 20 mWC	2(1W+1S)	PP
18.	Bulk Acid Storage Tank	3.2 m Dia X 6.3 m Los (Rev-03)	2 Nos	CSRL
19.	Acid Measuring Tank for SAC	1.3 m (Dia) X 1.27 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-02)	2 Nos	CSRL
20.	Acid Measuring Tank for MB	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-02)	1 No	CSRL
21.	Acid Measuring Tank for N-Pit	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-03)	1 No	CSRL
22.	Caustic Unloading Pump	15 m3/hr @ 20 mWC	2(1W+1S)	SS316
23.	Bulk Caustic Storage Tank	2.3 m Dia X 4.2 m Los(Rev-03)	2 Nos	CSRL
24.	Caustic Measuring Tank for SBA	1.1 m (Dia) X 1.3 m (Ht) + 0.3 m (FB)+ 0.1 m Dead depth(Rev-02)	2 Nos	CSRL
25.	Caustic Measuring tank for MB	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-02)	1 No	CSRL
26.	Caustic Measuring Tank for N-Pit	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-04)	1 No	CSRL
27.	Activated Carbon Filter for Alkali	1.0 m Dia X 2.7 m Hos	1 No	CSRL
28.	Alkali Brine Solution Preparation Tank	3 m (Dia) X 3.6 m (Ht) + 0.3 m (FB) + 0.1m Dead depth(Rev-02)	1 No	CSRL
29.	Dilution Water Heater for Alkali (Hot Water Tank)	2.2 m Dia X 2.6 m Hos(Rev-03)	1 No	SS316
30.	Heater	40 kW(Rev-03)	2 No	
31.	Neutralization Pit	8 m (L) X 8 m (B) X 2.5 m	1 No	RCC

		(Ht) + 0.5 m (FB)+0.1m Dead depth (each compartment)(Rev-03)	(In two compartments)	
32.	Neutralized Effluent Disposal Pumps for each compartment	40 m3/hr @ 31 mWC(Rev-03)	2(1W+1S)	SS316
33.	Filter Backwash Sump	7 m (L) X 7 m (B) X 3 m (Ht) + 0.5 m (FB)+ 0.1m Dead depth (each compartment)(Rev-03)	1No (In two compartments)	RCC
34.	Backwash Waste Water Disposal Pump	75 m3/hr @ 35mWC(Rev-04)	2(1W+1S)	Ni CI/SS316
35.	Dual Media Filter	1.4 m Dia X 2.7 m Hos	2(1W+1S)	CSEP
36.	Air Blower for Dual Media Filter	62 m3/hr @ 4000 mmWC(Rev-03)	2(1W+1S)	CI
37.	Sodium Hypochlorite Dosing tank	0.5 m (Dia) X 0.625 m (Ht) + 0.3 m (FB)+ 0.1 m Dead depth(Rev-02)	1 No	CSRL
38.	Sodium Hypochlorite Solution Dosing Pump	0-4 LPH	2(1W+1S)	CI
39.	Alkali Transfer Cum Recirculation Pump	10 m3/hr @ 20 mWC	2(1W+1S)	SS316

Chapter 5 MASS BALANCE

Mass balance in m3and (m3/18 hr) basis(Rev-03)



Note:
The mass balance is prepared on 18 hr basis, however the filter backwash and rinse occurs only 24 hrs once, hence the waste generated during filter backwash is converted to 18 hr basis as follows
Volume of water required for DMF, potable DMF (only backwash) and ACF backwash and rinse = 118.51 m3
Volume of water required for DMF, potable DMF (only backwash) and ACF backwash and rinse (18 hr basis)
= 118.51*18/24
= 88.62 m3

Chapter 6 PROCESS DESIGN & SIZING CALCUALTION

DEMINERALISATION PLANT			
DM FEED PUMPS			
1.	Quantity	3 (1W + 2S)	Nos
2.	Capacity required (Please Refer mass balance)	117.42(Rev-03)	m3/hr
3.	Capacity provided	120	m3/hr
4.	Head	50(Rev-02) (please refer attached pressure drop calculation)	mWC
5.	Shut-off head (Rev-02)	55	mWC
6.	Efficiency at rated capacity (Rev-02)	65	%
7.	Type	Horizontal Centrifugal	
	Material of Construction		
1.	Casing	SS-316	
2.	Impeller	SS-316	
3.	Rated Speed	1500	rpm
DUAL MEDIA PRESSURE FILTERS			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate required (Please refer mass balance)	117.42(Rev-03)	m3/hr
4.	Design Flow Rate	118(Rev-03)	m3/hr
5.	Net Flow rate at the outlet of MB	105	m3/hr

6.	Design Surface Flow rate	10	m3/m2/hr
7.	Area of Filter	11.8(Rev-03)	m2
8.	Diameter	3.88(Rev-03)	M
9.	Diameter provided	3.9	M
10.	Area of Filter provided	11.94	m2
11.	Type of Filter Media	Bed of Graded Sand and Anthracite Supported over Graded Gravel.	
12.	Bed Depth	Anthracite 350, sand 750	mm
13.	Supporting media - Gravel	500	mm
14.	Total Bed Depth Provided	1600	mm
15.	Free Board	80	%
16.	Height of Filter	2880	mm
17.	Height of Filter Provided	2900	mm
18.	B/w Velocity	24	m/hr
19.	B/w Flow	287	m3/hr
20.	B/w Time	15	Min
21.	B/W Volume	72	m3
22.	Air Scoring Velocity	40	m/hr
23.	Air Blower Flow rate	478	m3/hr
24.	Material of Construction	CSEP	
25.	Design Inlet TSS	20 (minimum)	ppm
26.	Outlet TSS	Not more than 1.0	ppm
AIR BLOWER FOR DUAL MEDIA PRESSURE FILTERS			
1.	Quantity	2 (1W + 1S)	Nos
2.	Blower Velocity	40	m/hr

3.	Blower Capacity Required	= (area of filter * blower velocity) =11.94*40 =478	m3/hr
4.	Blower Capacity Provided	480	m3/hr
5.	Head	4000 (please refer attached pressure drop calculation)	mmWC
6.	Type	Rotary Twin Lobe Oil Free	
	Material of Construction		
1.	Casing	CI as per IS-210, Gr FG260	
2.	Lobe	CI as per IS-210, Gr, FG260	
OVERHEAD BACKWASH WATER STORAGE TANK			
1.	Quantity	1	No
2.	Type	Rectangular and overhead	
3.	Water required for DMF backwash	72	m3
4.	Water required for one Potable Water Plant DMF backwash	10	m3
5.	Capacity required for single backwash of one (1) no. Dual Media Filters of DM Plant + single backwash of two (2) nos. Dual Media Filters of PotableWater Treatment Plant + 20 % overall margin.	111 (Rev-02)	m3
6.	Material of Construction	RCC	
7.	Dimensions(Rev-05)	7.3 m (L) X 5.4 m (B) X 3 m (Ht) + 0.5 m (FB) + 0.1 m Dead Depth(Rev-05)	
8.	**Scope**	**By BHEL**	
9.	Minimum pressure required for Backwash	15	mWC
10.	Minimum water level has to be maintained in the overhead tank	0.5	m

11.	Elevation of tank required to meet the required backwash pressure	14.5	mWC
ACTIVATED CARBON FILTERS			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer Mass Balance)	112.5(Rev-03)	m3/hr
4.	Design Flow Rate	113(Rev-03)	m3/hr
5.	Net Flow rate at the outlet of MB	105	m3/hr
6.	Design Surface Flow rate	15	M3/m2/hr
7.	Area of Filter	7.533(Rev-03)	m2
8.	Diameter	3.098(Rev-03)	M
9.	Diameter provided	3.1	M
10.	Area of Filter provided	7.55 (Rev-02)	m2
11.	Type of Filter Media	Activated Carbon	
12.	Bed Depth	Activated Carbon 1200, Support Gravel 450	mm
13.	Total Bed Depth Provided	1650	mm
14.	Free Board	80	%
15.	Height of Filter	2970	mm
16.	Height of Filter Provided	3000	mm
17.	B/w Velocity	9	m/hr
18.	B/w Flow	68	m3/hr
19.	B/w Time	15	Min
20.	B/W Volume	17	m3
21.	Material of Construction	CSEP	

WEAK ACID CATION EXCHANGER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer Mass Balance and attached DM projection)	112.26(Rev-03)	m3/hr
4.	Net flow (18 hr basis)	111.28(Rev-03)	m3/hr
5.	Water for regeneration (18 hr basis)	0.98(Rev-03)	m3/hr
6.	Design Flow Rate	112.26(Rev-03)	m3/hr
7.	Net Flow rate at the outlet of MB	105	m3/hr
8.	Operating hours	18	hrs
9.	Net OBR	1890	M3
10.	Design surface flow rate	39.9(Rev-03)	M3/m2/hr
11.	Internal Dia (Excluding Rubber lining)Provided (Please refer attached Annexure-1)	1900	mm
12.	Bed Depth (Please refer attached Annexure-1)	Effective Bed Depth 1121, (Rev-03)	mm
13.	Resin volume required	3148(Rev-03)	Ltrs
14.	Resin Volume provided (Please refer attached Annexure-1)	3150(Rev-03)	Ltrs
15.	Type of Resin	Cross linked Polyacrylic Acid Containing Carboxylic Acid Functional group	
16.	Trade Name	Purolite® C104Plus	
17.	Free Board	80	%
18.	Height Provided	2100(Rev-03)	mm
19.	Material Of Construction	CSRL with cleats of internal supports of SS316	(Rev-02)

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NAME: GAIENDRA SINGH	

STRONG ACID CATION EXCHANGER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer Mass Balance and attached DM projection)	111.28(Rev-03)	m3/hr
4.	Design Flow Rate	111.28(Rev-03)	m3/hr
5.	Net Flow rate at the outlet of MB	105	m3/hr
6.	Operating hours	18	hrs
7.	Net OBR	1890	M3
8.	Design surface flow rate	39.6(Rev-03)	M3/m2/hr
9.	Internal Dia (Excluding Rubber lining) Provided (Please refer attached Annexure-1)	1900	mm
10.	Bed Depth (Please refer attached Annexure-1)	Effective Bed Depth 1156, Inert Bed Depth 150(Rev-03)	mm
11.	Resin Volume (Please refer attached Annexure-1)	3245(Rev-03)	Ltrs
12.	Inert resin Volume	425	Ltrs
13.	Type of Resin	Strongly Acidic Polystyrene microporous Resin with DBV cross linking(Rev-03)	
14.	Trade Name	Purolite® PFC100H	
15.	Free Board	80	%
16.	Height Provided	2400	mm
17.	Material Of Construction	CSRL with cleats of internal supports of SS316	(Rev-02)

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DEGASSER TOWER			
1.	Quantity	2 (1W+1S)	Nos
2.	Gross Flow rate (Please refer Mass Balance)	110.87(Rev-03)	m3/hr
3.	Net flow (18 hr basis)	108.15(Rev-03)	m3/hr
4.	Water for regeneration (18 hr basis)	2.72(Rev-02)	m3/hr
5.	Design Flow Rate (120% of gross flow)	133(Rev-02)	m3/hr
6.	Net Flow Rate at the outlet of MB	105	m3/hr
7.	Maximum and minimum capacity	20 % and 120 %(Rev-02)	m3/hr
8.	Surface Flow rate	60	m3/m2/hr (Rev-04)
9.	Area required	2.22 (Rev-02)	m2
10.	Diameter Required	1.68 (Rev-02)	m
11.	Internal Dia (Excluding Rubber lining) Provided	1.7	M
12.	Packing Height	2.5 (Rev-02)	m
13.	Height of Tower with 50% free board	3.75 (Rev-02)	m
14.	Media Provided	PP Rings	
15.	Packing Volume/Tower	5.672 (Rev-02)	m3
16.	CO2 at the outlet of degasser tower	Shall be less than 5 ppm as CO2 (Rev-02)	
17.	Material of construction	CSRL	
DEGASSER AIR BLOWERS			
1.	Quantity	4 (1W + 1S for each stream)	Nos
2.	Type of Blower	Centrifugal, Oil free	
3.	Air : Water Ratio	23.5(Rev-02)	m/hr

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4.	Blower Capacity	=133 * 23.5 =3125.5(Rev-02)	m3/hr
5.	Blower Capacity selected	3150(Rev-02)	m3/hr
6.	Head	100 (please refer attached pressure drop calculation)	mmWC
	Material of Construction		
1.	Casing	CI/CS	
2.	Impeller	CI/CS	
DEGASSED WATER STORAGE TANK			
1.	Quantity	2 (1 No for Each stream)	Nos.
2.	Type	Horizontal Cylindrical with Dished Ends	
3.	Capacity with 20% margin (Please Refer annexure - 2 Table A.2.2)	185(Rev-02)	m3
4.	Dimensions (Inclusive of 0.3 m FB+ 0.1 m Dead depth)	4.8 m (Dia) X 9 m (LOS)(Rev-02)	
5.	Material of Construction	CSRL	
For dimension arrival calculation, pls refer Annexure – 2, Table no.A. 2.3			
DEGASSED WATER TRANSFER PUMPS			
1.	Quantity	4(1W + 1S for each stream)	Nos
2.	Capacity	120 (Rev-02)	m3/hr
3.	Head	45(Rev-03) (please refer attached pressure drop calculation)	mWC
4.	Shut-off head(Rev-02)	49.5(Rev-03)	mWC
5.	Efficiency at rated capacity(Rev-02)	65	%
6.	Type	Horizontal Centrifugal	
	Material of Construction		

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1.	Casing	SS-316	
2.	Impeller	SS-316	
3.	Rated Speed	1500	rpm
WEAK BASE ANION EXCHANGER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer Mass Balance and attached DM projection)	108.55(Rev-03)	m3/hr
4.	Net flow (18 hr basis)	107.57(Rev-03)	m3/hr
5.	Water for regeneration (18 hr basis)	0.98(Rev-03)	m3/hr
6.	Design Flow rate	108.55(Rev-03)	m3/hr
7.	Net Flow rate at the outlet of MB	105	m3/hr
8.	Operating hours	18	Hrs
9.	Net OBR	1890	M3
10.	Design surface flow rate	38.7(Rev-03)	M3/m2/hr
11.	Internal Dia (Excluding Rubber lining) Provided (Please refer attached Annexure-1)	1900	Mm
12.	Bed Depth (Please refer attached Annexure-1)	Effective Bed Depth 1048(Rev-02)	Mm
13.	Resin volume required	2942(Rev-03)	Ltrs
14.	Resin Volume (Please refer attached Annexure-1)	2945(Rev-03)	Ltrs
15.	Type of Resin	High Capacity macro porous polystyrene resin with DBV cross- linking and tertiary amine functional group having weak base capacity not less than 80%	

16.	Trade Name	Purolite® A100Plus	
17.	Free Board	100	%
18.	Height Provided	2100(Rev-03)	mm
19.	Material Of Construction	CSRL with cleats of internal supports of SS316	(Rev-02)
STRONG BASE ANIONEXCHANGER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer mass balance and attached DM projection)	107.57(Rev-03)	m3/hr
4.	Net flow (18 hr basis)	106.83(Rev-03)	m3/hr
5.	Water for regeneration (18 hr basis)	0.74(Rev-03)	m3/hr
6.	Design Flow Rate	107.57(Rev-03)	m3/hr
7.	Net Flow rate at the outlet of MB	105	m3/hr
8.	Operating hours	18	Hrs
9.	Net OBR	1890	M3
10.	Design surface flow rate	38.2	M3/m2/hr
11.	Internal Dia (Excluding Rubber lining)Provided (Please refer attached Annexure-1)	1900	Mm
12.	Bed Depth (Please refer attached Annexure-1)	Effective Bed Depth 1474, Inert bed Depth 150(Rev-03)	mm
13.	Resin volume required	4139(Rev-03)	Ltrs
14.	Effective Resin Volume (Please refer attached Annexure-1)	4140(Rev-03)	Ltrs

15.	Inert resin Volume	425	Ltrs
16.	Type of Resin(Rev-02)	High Capacity strongly basic Type-1 polystyrene resin with DBV cross linking and quaternary ammonium functional group –Chloride Form - Macroporous(Rev-03)	
17.	Trade Name	Purolite® PPA500 Plus	
18.	Free Board	100	%
19.	Height Provided	3300(Rev-03)	mm
20.	Material Of Construction	CSRL with cleats of internal supports of SS316	(Rev-02)
MIXED BED EXCHANGER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Gross Flow rate (Please refer Mass Balance and attached DM projection)	106.83(Rev-02)	m3/hr
4.	Net Flow rate at the outlet of MB	105	m3/hr
5.	Water for regeneration (126 hr basis for MB and 18 hrs for WBA , SBA.)	1.83(Rev-02)	m3/hr
6.	Design Flow rate	106.83(Rev-02)	m3/hr
7.	Time Period for each Service Cycle between two consecutive regenerations(Rev-02)	126	hrs
8.	Net OBR	13230	M3
9.	Design surface flow rate	53.6	M3/m2/hr
10.	Internal Dia (Excluding Rubber lining) Provided (Please refer attached Annexure-1)	1600	mm
11.	Bed Depth (Please refer attached	Cation Resin 503& Anion Resin 503& Inert resin	mm

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	Annexure-1)	(Anion – 75& Cation resin – 75) (Rev-03)	
12.	Resin Volume (Please refer attached Annexure-1)	Cation Resin 1000 & Anion Resin 1000	Ltrs
13.	Inert resin Volume (Rev-02)	Inert resin (Anion – 150& Cation resin – 150) (Rev-03)	Ltrs
14.	Type of Resin	Strongly Acidic Polystyrene Resin with DBV cross linking and High capacity strongly basic Type-1 Polystyrene resin with DBV cross linking and quaternary ammonium functional group - Macroporous. (Rev-03)	
15.	Trade Name	Purolite® PFC100 and Purolite® PPA500(Rev-03)	
16.	Free Board	100	%
17.	Height Provided(Rev-02)	2400	mm
18.	Material Of Construction	CSRL with cleats of internal supports of SS316	(Rev-02)
AIR BLOWER COMMON FOR MIXED BED AND NEUTRALIZATION PIT			
1.	Quantity	2 (1W + 1S)	Nos
2.	Type of Blower	Rotary, Twin Lobe	
3.	Air required for 2 nos. MB(Rev-02)	=2 * Area of MB Vessel * 120(air scouring Velocity) = 2 * 2.01 * 120= 484(Rev-03)	m3/hr
4.	Air required for 2 nos. MB(Rev-02)	484(Rev-03)	m3/hr
5.	Air required for NPIT	0.6 times the volume of N-PIT for mixing = (0.6*342) = 205.2 (Rev-02)	m3/hr
6.	Air required for NPIT	205.2 (Rev-02)	m3/hr
7.	Blower capacity required	689.2(Rev-03)	m3/hr
8.	Blower Capacity provided	700(Rev-03)	m3/hr
9.	Head	4000 (please refer attached pressure drop calculation)	mmWC

	Material of Construction		
1.	Casing	CI to IS210 FG 260	
2.	Lobes	CS to BS 970, EN9 Forged	
REGENERATION WATER TRANSFER PUMP			
1.	Quantity	2 (1W + 1S)	Nos
2.	Capacity	= Max flow required for slow rinse of SBA and WBA =6.2 +9(Rev-02) = 15.2	m3/hr
3.	Capacity provided with 20% margin	20(Rev-02)	m3/hr
4.	Head	30(Rev-01) (please refer attached pressure drop calculation)	mWC
5.	Shut-Off Head	35	mWC
6.	Efficiency	65	%
7.	Type	Horizontal Centrifugal	
	Material of Construction		
1.	Casing	SS-316	
2.	Impeller	SS-316	
3.	Rated Speed	1500	rpm
ACID MEASURING TANK FOR SAC			
1.	Quantity	2	Nos
2.	Type	Vertical Cylindrical with flat bottom	
3.	Chemical per Regeneration (Please refer attached Annexure-I)	454.3(Rev-03)	Kg
4.	Chemical available Concentration	30	%

5.	Specific Gravity @ Available Concentration	1.13 (Rev-02)	Kg/l
6.	Capacity required with 20 % margin(Rev-02)	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(452.9/1.13/30%)*1.2 =1609(Rev-03)	Litres
7.	Capacity provided with 20 % margin(Rev-02)	1650	Litres
8.	Dimensions	1.3 m (Dia) X 1.27 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth	
9.	Material of Construction	CSRL	
ACID MEASURING TANK FOR MB			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with flat bottom	
3.	Chemical per Regeneration (Please refer attached Annexure-I)	100	Kg
4.	Chemical available Concentration	30	%
5.	Specific Gravity @ Available Concentration	1.13 (Rev-02)	Kg/l
6.	Capacity required with 20 % margin	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(100/1.13/30%)*1.2 =354(Rev-02)	Litres
7.	Capacity provided with 20 % margin	400(Rev-02)	Litres
8.	Dimensions	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead Depth	
9.	Material of Construction	CSRL	

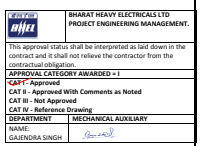
ACID MEASURING TANK FOR NEUTRALIZATION PIT (WHEN WAC, WBA, SAC, SBA ALONE ARE IN REGENERATION)			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with flat bottom	
3.	HCL Excess eq difference (Please refer attached Annexure-I)	= Excess NaOH – Excess HCL =4551-2221(Rev-03)	Eq
4.	Neutralizing Chemical per Regeneration	= Excess eq difference * 36.5/1000 =85.05(Rev-03)	Kg
5.	Chemical available Concentration	30	%
6.	Specific Gravity @ Available Concentration	1.13(Rev-02)	Kg/l
7.	Capacity required with 20 % margin	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(85.05/1.13/30%)*1.2 =302(Rev-03)	Litres
8.	Capacity provided	400	Litres
9.	Dimensions	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead Depth	
10.	Material of Construction	CSRL	
ACID MEASURING TANK FOR NEUTRALIZATION PIT (WHEN WAC, WBA, SAC, SBA AND MB ARE IN REGENERATION)			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with flat bottom	
3.	NaOH Excess Eq difference (Please refer attached Annexure-I)	= Excess NaOH– Excess HCL =((4551+2208)-(2221+2471)) = 2067(Rev-03)	Eq

4.	Neutralizing Chemical per Regeneration	= Excess Eq difference * 36.5/1000 =75.45(Rev-03)	Kg
5.	Chemical available Concentration	30	%
6.	Specific Gravity @ Available Concentration	1.13	Kg/l
7.	Capacity required with 20 % margin	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(75.45/1.13/30%)*1.2 =268(Rev-03)	Litres
8.	Capacity provided with 20 % margin	300	Litres

Since AMT for Npit requirement for without MB regeneration is higher than with MB. Hence AMT for Npit will be considered as 400 ltrs. (Rev-03)

BULK ACID STORAGE TANK

1.	Quantity	2	Nos
2.	Type	Horizontal Cylindrical with dished ends, over ground	
3.	Cycle Time for SAC	18	Hours
4.	Cycle Time for MB Cation	126	Hours
5.	Storage period	21	days
6.	Storage period in hours	= (21*24) = 504	hours
7.	No. of cycles for SAC	= (504/18) = 28	Nos.
8.	No. of cycles for MB Cation	= (504/126) = 4	Nos.
9.	No. of cycles for N-Pit Acid Requirement for neutralization (during WAC,SAC, WBA and SBA regeneration alone)	= (504/18) = 28	Nos.



10.	Chemical Requirement for 28 Cycles for SAC(Rev-03)	= (kg req per regeneration /Sp.gravity /concentration/1000) * 28 =(454.3/1.13/30%/1000)*28 =37.523	m3
11.	Chemical Requirement for 4 Cycles for MB Cation(Rev-03)	= (kg req per regeneration /Sp.gravity /concentration/1000) * 4 =(100/1.13/30%/1000)*4 =1.18	m3
12.	Chemical Requirement for 28 Cycles for N-Pit Acid Requirement(during WAC,SAC, WBA and SBA regeneration alone is considered since including MB will be the chemical quantity will be lesser) (Rev-03)	= (kg req per regeneration /Sp.gravity /concentration/1000) * 28 =(85.05/1.13/30%/1000)*28 =6.97	m3
13.	Capacity of tank with 20% margin(Rev-03)	54.8	m3
14.	Dimensions (including 0.3 m FB and 0.1 m dead depth)(Rev-03)	3.2 m (Dia) X 6.3 m (LOS)	
For dimension arrival calculation, pls refer Annexure – 2, Table no.A. 2.3			
15.	Material of Construction	CSRL	
ACID UNLOADING PUMP			
1.	Quantity	2 (1W + 1S)	Nos
2.	Capacity	15	m3/hr
3.	Head	20	mWC
4.	Type	Horizontal Centrifugal Non Clog	

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	Material of Construction		
1.	Casing	PP	
2.	Impeller	PP	
3.	Rated Speed	1500	rpm
CAUSTIC MEASURING TANK FOR SBA			
1.	Quantity	2	Nos
2.	Type	Vertical Cylindrical with flat bottom	
3.	Chemical per Regeneration (Please refer attached Annexure-I)	372.6 (Rev-03)	Kg
4.	Chemical available Concentration	30	%
5.	Specific Gravity @ Concentration in measuring tank	1.3	Kg/l
6.	Capacity required with 20 % margin	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(372.6/1.3/30%)*1.2 =1147(Rev-03)	Litres
7.	Capacity provided with 20 % margin	1200	Litres
8.	Dimensions(Rev-02)	1.1 m (Dia) X 1.3 m (Ht) + 0.3 m (FB) + 0.1 m Dead Depth	
9.	Material of Construction	CSRL	
CAUSTIC MEASURING TANK FOR MB			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with flat bottom	
3.	Chemical per Regeneration (Please refer attached Annexure-I)	100	Kg

4.	Chemical available Concentration	30	%
5.	Specific Gravity @ Available Concentration	1.3	Kg/l
6.	Capacity required with 20 % margin	= (kg req per regeneration /Sp.gravity /concentration)+20% margin =(100/1.3/30%)*1.2 =308	Litres
7.	Capacity provided with 20 % margin	400	Litres
8.	Dimensions(Rev-02)	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth	
9.	Material of Construction	CSRL	
CAUSTIC MEASURING TANK FOR NEUTRALIZATION PIT (WHEN WAC, WBA, SAC, SBA ALONE ARE IN REGENERATION)OR(WHEN WAC, WBA, SAC, SBA MB ARE IN REGENERATION) – in both cases acid is used for the neutralization. however Safety factor and in order to meet tender requirement CMT for NPIT is provided as below details. (Rev-03)			
1.	Quantity	1	No
2.	Capacity provided with 20 % margin	400 (Rev-04)	Litres
3.	Dimensions	0.8 m (Dia) X 0.825 m (Ht) + 0.3 m (FB) + 0.1 m Dead depth(Rev-04)	
4.	Material of Construction	CSRL	
BULK CAUSTIC STORAGE TANK			
1.	Quantity	2	Nos
2.	Type	Horizontal Cylindrical with dished ends	
3.	Cycle Time for SBA	18	Hours

4.	Cycle Time for MB Anion	126	Hours
5.	Storage period	21	days
6.	Storage period in hours	=21*24 =504	hours
7.	No. of cycles for SBA	=504/18 =28	Nos.
8.	No. of cycles for MB Anion	=504/126 = 4	Nos.
9.	No. of cycles for N-Pit Alkali Requirement (during SBA,WBA,MB anion regeneration)	=504/126 = 4	Nos.
10.	Chemical Requirement for 28 Cycles for SBA	= (kg req per regeneration /Sp.gravity /concentration) * 28 =(372.6/1.47/48%/1000)*28 =14.79 (Rev-03)	m3
11.	Chemical Requirement for 4 Cycles for MB Anion	= (kg req per regeneration /Sp.gravity /concentration/1000) * 4 =(100/1.47/48%/1000)*4 =0.57(Rev-02)	m3
12.	Capacity of tank with 20% margin	18.44(Rev-03)	m3
13.	Dimensions including 0.3 m FB and 0.1 m dead depth (Rev-03)	2.3 m (Dia) X 4.2 m (LOS)	
For dimension arrival calculation, pls refer Annexure – 2, Table no.A. 2.3			
14.	Material of Construction	CSRL	
CAUSTIC UNLOADING PUMP			
1.	Quantity	2 (1W + 1S)	Nos
2.	Capacity	15	m3/hr
3.	Head	20	mWC

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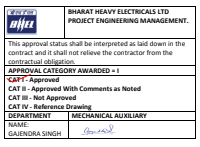
4.	Type	Horizontal Centrifugal Non Clog	
	Material of Construction		
1.	Casing	SS316	
2.	Impeller	SS316	
3.	Rated Speed	1500	rpm
ALKALI TRANSFER CUM RECIRCULATION PUMPS			
1.	Quantity	2(1W + 1S)	Nos
2.	Capacity	10	m3/hr
3.	Head	20	mWC
4.	Type	Horizontal Centrifugal Non-Clog	
	Material of Construction		
1.	Casing	SS316	
2.	Impeller	SS316	
3.	Rated Speed	1500	rpm
ACTIVATED CARBON FILTER FOR ALKALI SERVICE			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with dished ends	
3.	Flow rate	10	m3/hr
4.	Design Surface Flow rate	15	m3/m2/hr
5.	Area of Filter	0.67	m2
6.	Diameter	0.922	m
7.	Internal Diameter provided (Excluding Rubber Lining)	1	m
8.	Area of Filter provided	0.785	m2
9.	Type of Filter Media	Activated Carbon	

10.	Bed Depth	Activated Carbon 1200, Support Gravel 300	mm
11.	Total Bed Depth Provided	1500	mm
12.	Free Board	75	%
13.	Height of Filter	2625	mm
14.	Height of Filter Provided	2700	mm
15.	Material of Construction	CSRL	
ALKALINE BRINE SOLUTION PREPARATION TANK			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with flat bottom	
3.	Capacity	=5 Bed Volumes of SBA =(5*4.14) =20.7	
4.	Capacity provided with 20% margin	25	M3
5.	Dimensions(Rev-03)	3 m (Dia) X 3.6 m (Ht) + 0.3 m (FB) + 0.1m Dead depth	
6.	Material of Construction	CSRL	
DILUTION WATER HEATER FOR ALKALI (HOT WATER TANK)			
1.	Quantity	1	No
2.	Type	Vertical Cylindrical with dished ends. Heater-Immersion Coil	
3.	Bed Warming	=1 Bed Volume of SBA =(1*4140)(Rev-03) =4140	 Litres
4.	Hot water required for Alkali injection	=6570 (please refer attached Annexure – 1)(Rev-03)	Litres

5.	Capacity with 20% margin	=Bed Warming + Hot water required for slow rinse = (4140+6570)*1.2 =12852(Rev-03)	Litres
6.	Capacity with 20% margin	12.9(Rev-03)	m3
7.	Dimensions (Excluding Dish Length)	2.2 m (Dia) X 2.6 m (HOS)	
8.	Mass of water (m)	= Volume * Density = 12.9*1000 =12900(Rev-01)	kg
9.	Specific Heat (Cp)	4.184	KJ/Kg/K
10.	Temperature increase required (dt)	30 (from 10 degree to 40 degree)	Degree Celsius or K
11.	Heating time	=6 =21600	hrs secs
12.	Heat required	= mCpdt/t = 12900*4.184*30/21600 = 74.5(Rev-03)	KW
13.	Heater KW with 95%	=74.5/0.95 = 79(Rev-03)	KW
14.	Capacity provided	=2 X 50 % = 2 X 40(Rev-03)	KW
15.	Material of Construction	SS316	
NEUTRALIZATION PIT			
1.	Quantity	1 with two compartments	No
2.	Type	Underground and Rectangular in Cross-Section	
3.	Capacity with 20% margin for each compartment (for detailed calculation, Please refer Table A.2.1)	155(Rev-01)	m3

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4.	Dimensions	8 m (L) X 8 m (B) X 2.5 m (Ht) + 0.5 m (FB)+ 0.1 m Dead Depth (Rev-02)	
5.	Material of Construction	RCC	
6.	**Scope**	**By BHEL**	
NEUTRALIZED EFFLUENT DISPOSAL PUMP			
1.	Quantity	4 (1W + 1S for each compartment)	Nos
2.	Volume of effluent to be disposed	155(Rev-02)	m3
3.	Operating hours	24	hrs
4.	Capacity required	= 155/18 =8.62	m3/hr
5.	Capacity provided with 20 % margin	40	m3/hr
6.	Head	31(Rev-03) (please refer attached pressure drop calculation)	mWC
7.	Shut-off Head	53	mWC
8.	Efficiency	65	%
9.	Type	Horizontal Centrifugal Non Clog	
	Material of Construction		
1.	Casing	SS316	
2.	Impeller	SS316	
3.	Rated Speed	1500	rpm
FILTER BACKWASH SUMP			
1.	Quantity	1 with two compartments	No
2.	Type	Rectangular with flat bottom	
3.	Water required for DMF backwash and Rinse	81.78(Rev-03)	m3
4.	Water required for one Potable Water Plant DMF	11.25	m3

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	backwash and Rinse		
5.	Water required for ACF backwash and Rinse	26.4(Rev-02)	m3
6.	Total backwash wash (Suitable to hold backwash waste generated from single backwash of one (1) number Dual Media Filter and activated carbon filter in a day)	119.43(Rev-03)	m3
7.	Capacity provided with 20% margin	144(Rev-03)	m3
8.	Material of Construction	RCC	
9.	Dimensions	7m (L) X 7 m (B) X 3 m (Ht) + 0.5 m (FB) + 0.1 m Dead Depth	
10.	**Scope**	**By BHEL**	
BACKWASH WASTE WATER DISPOSAL PUMP			
1.	Quantity	2(1W + 1S)	Nos
2.	Capacity	75 (Rev-03)	m3/hr
3.	Head	35(Rev-04) (please refer attached pressure drop calculation)	mWC
4.	Shut-off Head	38(Rev-03)	mWC
5.	Efficiency	50	%
6.	Type	Vertical Centrifugal Non Clog	
	Material of Construction		
1.	Casing	Ni Hard CI as per ASTM 532	
2.	Impeller	Ni Hard CI as per ASTM 532	
3.	Rated Speed	1500	rpm

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POTABLE WATER TREATMENT PLANT			
DUAL MEDIA FILTER			
1.	Quantity	2 (1W+1S)	Nos
2.	Type	Vertical Cylindrical with dished ends	
3.	Flow rate	15	m3/hr
4.	Design Surface Flow rate	10	M3/m2/hr
5.	Design Inlet Turbidity	15	NTU
6.	Design Outlet Turbidity	Not more than 1	NTU
7.	Area of Filter	1.5	M2
8.	Diameter	1.382	M
9.	Diameter provided	1.4	M
10.	Area of Filter provided	1.5386	m2
11.	Type of Filter Media	Bed of Graded Sand and Anthracite Supported over Graded Gravel.	
12.	Bed Depth	Anthracite 350, sand 750	mm
13.	Supporting media - Gravel	350	mm
14.	Total Bed Depth Provided	1450	mm
15.	Free Board	80	%
16.	Height of Filter	2610	mm
17.	Height of Filter Provided	2700	mm
18.	B/w Velocity	24	m/hr
19.	B/w Flow	37	m3/hr
20.	B/w Time	15	Min
21.	B/W Volume	10	m3
22.	Air Scoring Velocity	40	m/hr

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23.	Air Blower Flow rate	62	m3/hr
24.	Material of Construction	CSEP	
AIR BLOWER FOR DUAL MEDIA PRESSURE FILTERS			
1.	Quantity	2 (1W + 1S)	Nos
2.	Blower Velocity	40	m/hr
3.	Blower Capacity	62	m3/hr
4.	Head	4000	mmWC
5.	Type	Rotary Twin Lobe Oil Free	
	Material of Construction		
1.	Casing	CI as per IS-210, Gr FG260	
2.	Lobe	CI as per IS-210, Gr, FG260	
SODIUM HYPOCHLORITE SOLUTION DOSING PUMP			
1.	Quantity	2(1W+1S)	Nos
2.	Type of Pump	Metering Pump	
3.	Water Flowrate	15	m3/hr
4.	Dosage ppm	3	ppm
5.	Dosage Rate	0.009	Kg/hr
6.	Specific Gravity	1.1	Kg/l
7.	Dosage Rate at 100%	= Dosage Rate/Specific gravity = 0.009/1.1 = 0.0086	LPH
8.	Dosing Rate at10%	=Dosage Rate at 100%/10% concentration =0.0086/10% =0.086	LPH
9.	Pump Capacity Provided	0-4	LPH
	Material of Construction		

1.	All wetted parts	CI to IS210 FG 260	
2.	Casing	CI as per IS-210, Gr. FG 260	
3.	Speed	1500	rpm
SODIUM HYPOCHLORITE DOSING TANK			
1.	Quantity	1	No.
2.	Type	Vertical Cylindrical With flat bottom	
3.	Retention Time	30	Days
4.	Capacity required	=Dosing Rate at 10% * 30 *24 =0.086*30*24 =62	Ltrs
5.	Capacity Provided	100	Ltrs
6.	Dimensions	0.5 m (Dia) X 0.625 m (Ht) + 0.3 m (FB) + 0.1 m Dead Depth	
7.	Material of Construction	CSRL	

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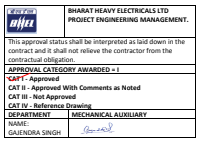
Chapter 7

RESIN DATASHEETS

LIST OF RESIN

S.NO	RESIN NAME	RESIN MODEL
1	WEAK ACID CATION	Purolite® C104Plus
2	STRONG ACID CATION	Purolite® PFC100H
3	WEAK BASE ANION	Purolite® A100Plus
4	STRONG BASE ANION	Purolite® PPA500 Plus(Rev-03)
5	MB - CATION	Purolite® PFC100H
6	MB - ANION	Purolite® PPA500 Plus(Rev-03)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Purolite® C104Plus

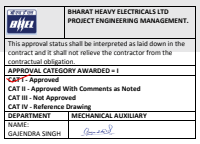
PRODUCT DATA SHEET

Porous Weak Acid Cation Exchange Resin

Purolite C104Plus is a premium grade polyacrylic weak acid cation exchanger. The functional groups of the carboxylic type give high chemical efficiency in many applications, especially for the removal of bicarbonate alkalinity in water treatment, showing good rates of exchange. Its major use is in the dealkalization and softening of waters and thereby the ionic load on the subsequent strong acid resin bed can be reduced. Because it has a lower density than the conventional strong acid resins, **Purolite C104Plus** is ideal for use in layered beds (**Doublite**) which can be economically regenerated by an upflow counter-current technique. This product has also been used to selectively recover transition metals from aqueous solutions.The resin is insoluble in acids, alkalies, and all common solvents. Its physical characteristics are outstanding, and oftenpermit its use where a macroporous resin might otherwise be indicated. Hence **Purolite C104Plus** may be operated successfully at relatively high temperatures, e.g. in sugar treatment. However, the macroporous polyacrylic weak acid cation exchanger **Purolite C106** is generally recommended where it is required to work between the acid and the highly-swollen alkali salt form (for example in the treatment of ammoniacal condensate waters or high solids softening). Weakly acidic cation resins are increasingly being used in special applications including treatment of waste water streams in order to reduce environmental pollution.

Typical Physical and Chemical Characteristics

Application	Dealkalization, Deionization; Softening - High Capacity
Polymer Structure	Porous crosslinked polyacrylic
Appearance	Spherical beads
Functional Group	Carboxylic Acid
Ionic Form as Shipped	H^+
Total Capacity (min.)	4.5 eq/l (98.3 Kgr/ft^3 (H^+ form))
Moisture Retention	45 - 55 % (H^+ form)
Particle Size Range	300 - 1600 µm
<300 µm (max.)	1 %
Reversible Swelling, $H^+ \rightarrow Ca^{2+}$ (max.)	20 %
Reversible Swelling, $H^+ \rightarrow Ca^{2+}$ (operating)	7 % (approx.)
Reversible Swelling, $H^+ \rightarrow Na^+$ (max.)	70 %
Specific Gravity	1.19
Shipping Weight (approx.)	740 - 780 g/l (46.3 - 48.8 lb/ft^3)
Temperature Limit	120°C (250°F)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CAT IV - Reference Drawing
DEPARTMENT: MECHANICAL AUXILIARY
NAME: GAJENDRA SINGH

Purolite®

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Purofine® PFC100H

PRODUCT DATA SHEET

Gel Strong Acid Cation Resin - Hydrogen Form, Uniform Particle Size

Principal Applications

- Industrial demineralization

Advantages

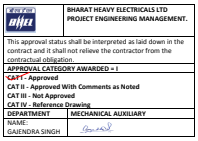
- Efficient regeneration
- Efficient separation
- Good physical and chemical stability
- High operating capacity
- Lower pressure drop versus standard resin
- Lower rinse volumes
- Superior kinetic performance

Systems

- Coflow regenerated systems
- Counterflow regenerated systems

Typical Physical and Chemical Characteristics

Application	Demineralization - Uniform Beads
Polymer Structure	Gel polystyrene crosslinked with DVB
Appearance	Amber, clear spherical beads
Functional Group	Sulfonic acid
Ionic Form as Shipped	H^+
Total Capacity (min.)	2.0 eq/l (43.7 Kgr/ft^3) (Na^+ form)
Moisture Retention	51 - 55 % (H^+ form)
Mean Diameter	570 ± 50 µm
Uniformity Coefficient (max.)	1.1 - 1.2
Reversible Swelling, $Na^+ \rightarrow H^+$ (max.)	8 %
Specific Gravity	1.20 (H^+ form)
Shipping Weight (approx.)	745 - 770 g/l (46.6 - 48.1 lb/ft^3)
Temperature Limit	120°C (250°F)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Purolite® A100Plus

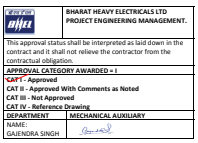
PRODUCT DATA SHEET

Macroporous Weak Base Anion Exchange Resin

Purolite A100Plus is a macroporous polystyrenic weak base anion resin having tertiary amine functionality.It is designed to exhibit high operating capacity in removing strong acids formed after decationizing water through a strong acid cation resin like Purolite C100H. Because of its special porosity characteristics **Purolite A100Plus** shows excellent properties for removal of naturally occurring organic species from waters along with superior elution efficiency of the organics during regeneration. **Purolite A100Plus** also shows excellent resistance to osmotic shock as well as being physically resistant to mechanical breakage. Regeneration with caustic soda requires only 125% of the stoichiometric equivalent when related to the ionic loading on the resin at the exhaustion point. The rinse characteristics are good and minimum volumes of decationized water are required to rinse down to a conductivity of 50 µS/cm.

Typical Physical and Chemical Characteristics

Application	Demineralization - Resistant to Organic Fouling
Polymer Structure	Macroporous Polystrene Crosslinked with Divinylbenzene
Appearance	Spherical beads
Functional Group	Tertiary Amine
Ionic Form as Shipped	Free Base
Total Capacity (min.)	1.3 eq/l (28.4 Kgr/ft^3) (Free Base form)
Moisture Retention	53 - 62 % (Cl^- form)
Particle Size Range	300 - 1200 µm
<300 µm (max.)	1 %
Uniformity Coefficient (max.)	1.7
Reversible Swelling, FB → Cl^- (max.)	25 %
Specific Gravity	1.04
Shipping Weight (approx.)	655 - 685 g/l (40.9 - 42.8 lb/ft^3)
Temp Limit, Cl^- Form	100°C (212°F)
Temp Limit, Free Base Form	60°C (140°F)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Puropack® PPA500Plus

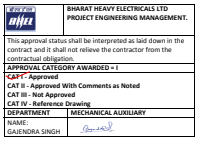
PRODUCT DATA SHEET

Macroporous Type I Strong Base Anion Exchange Resin

Puropack PPA500Plus is a specially produced, premium narrow size grading, macroporous type-I strong base anion exchange resin, ideal for use in packed beds. Its macroporous structure offers excellent resistance to osmotic and physical shock, as well as a good reversible sorptive capacity for complex organic materials, such as the fulvic and humic acids which occur in many surface water supplies. It is one of a range of **Puropack** products manufactured for use in modern day water treatment applications using packed beds. **Puropack PPA500Plus** is especially recommended for use in all counterflow demineralization systems, including the **Puropack** packed bed system. It has a specially tailored size grading which provides for economical regeneration by counterflow techniques. **Puropack** is a maximum performance packed bed system which provides a combination of superior engineering principles and improved resins that together optimize water treatment plant performance. For more information please refer to the **Puropack Manual** or your local **Purolite** Sales Office.

Typical Physical and Chemical Characteristics

Application	Demineralization - Uniformly Sized Packed Bed Grading
Polymer Structure	Macroporous polystyrene crosslinked with divinylbenzene
Appearance	Spherical beads
Functional Group	Type I Quaternary Ammonium
Ionic Form as Shipped	Cl^-
Total Capacity (min.)	1.15 eq/l (25.1 Kgr/ft^3) (Cl^- form)
Moisture Retention	57 - 63 % (Cl^- form)
Mean Size Typical	750 ± 100 µm
Uniformity Coefficient (max.)	1.2-1.4
Reversible Swelling, $Cl^- \rightarrow OH^-$ (max.)	20 %
Specific Gravity	1.08
Shipping Weight (approx.)	670 - 700 g/l (41.8 - 43.8 lb/ft^3)
Temp Limit, Cl^- Form	100°C (212°F)
Temp Limit, OH^- Form	65°C (150°F)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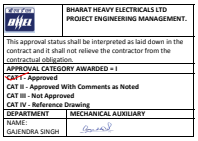
Chapter 8 PRESSURE DROP CALCUALTIONS

LIST OF PUMPS

1. DM PLANT FEED PUMPS
2. DG WATER TRANSFER PUMPS
3. REGENERATION WATER TRANSFER PUMPS
4. BACKWASH WASTE WATER DISPOSAL PUMPS
5. NEUTRALISED EFFULENT DISPOSAL PUMPS
6. AIR BLOWER FOR DMF
7. AIR BLOWER FOR DEGASSER
8. AIR BLOWER FOR MB AND NPIT
9. AIR BLOWER FOR DMF POTABLE



END USER:	GSECL, 1 X 800 MW WANAKBORI STPP
CLIENT :	M/S. BHEL
Doc. No	PE-V0-408-163-A003

CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL - WANAKBORI
Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

DM FEED PUMP - Capacity - 120 m3/hr @ 50 mWC head

FORMULA'S * $V = 0.849\ C\ R^{0.63}\ S^{0.54}$, Entry Loss = $0.5\ V^2/2g$, Exit Loss = $V^2/2g$ & Fitting Losses = $K \times V^2/2g$ x No. of fittings.

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	Pipe Coeff.	Slope S		Pipe	Entry &	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		C	*	1 in	Loss SxL	Exit loss	m
DM feed pump suction header - Common	DM feed pump suction header - Individual	200	120.0	0.0333	200	0.0500	0.031	1.061	3.00	CS	100	0.010	102	0.0296	0.0000	**0.0296**
DM feed pump suction header - Individual	Pump suction	200	120.0	0.0333	200	0.0500	0.031	1.061	1.50	CS	100	0.010	102	0.0148	0.0000	**0.0148**
Pump Discharge	Pump Discharge Header	150	120.0	0.0333	150	0.0375	0.018	1.886	1.50	CS	100	0.040	25	0.0600	0.0000	**0.0600**
Pump Discharge Header	To DMF (Rev-02)	200	240.0	0.0667	200	0.0500	0.031	2.122	200.00	CS	100	0.036	28	7.1114	0.0000	**7.1114**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bell mouth	Bend							Tee		Valve									Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
FROM	TO	NB mm	K val	0.10	11¼° 0.10	22½° 0.20	45° 0.35	90° 0.45	180° 1.50	Square 0.40	Miter 0.17	Branch 1.00	Main 0.40	Gate 0.17	Globe 6.00	Diaph. 2.60	Butter 0.24	Plug 9.00	Ball 0.30	Angle 2.00	Check 2.00	Foot 15.0	0.60	3.00		0.05				
DM feed pump suction header - Common	DM feed pump suction header - Individual	200	200.00									1																		**0.0574**
DM feed pump suction header - Individual	Pump suction	200	200.00														1													**0.0138**
Pump Discharge	Pump Discharge Header	150	150.00					1									1				1									**0.4878**
Pump Discharge Header	To DMF (Rev-02)	200	200.00					2																	2	41.2				**1.0925**

Frictional loss (Calculated)			**8.867**
Suction Head	0.000	1.00	**-1.000**
MAXIMUM HEAD LOSS IN THE DMF, ACF is 5 mWC in DMF and 7 mWC in ACF			**12.0**
MAXIMUM HEAD LOSS IN THE WAC (pl refer DM plant design software projection)			**7.0**
MAXIMUM HEAD LOSS IN THE SAC (pl refer DM plant design software projection)			**5.5**
Maximum Pipe Ht (static Head)			**12.0**
Total Head in M (Required)			**44.367**
TOTAL HEAD PROVIDED in M			**50**
Margin Available in % (Rev-02)			**12%**

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PROJECT ENGINEERING MANAGEMENT.

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CLIENT :	M/S. BHEL	CLIENT :	M/S. BHEL - WANAKBORI
Doc. No	PE-V0-408-163-A003	Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

DG WATER TRANSFER PUMPS - Capacity - 120 m3/hr @ 45 mWC head (Rev-02)

FORMULA'S * $V = 0.849\ C\ R^{0.63}\ S^{0.54}$, Entry Loss = $0.5\ V^2/2g$, Exit Loss = $V^2/2g$ & Fitting Losses = $K \times V^2/2g$ x No. of fittings.

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	Pipe Coeff.	Slope S		Pipe	Entry &	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		C	*	1 in	Loss SxL	Exit loss	m
DG water transfer pump suction header - Common	DG water transfer pump suction header - Individual	200	120.0	0.0333	194	0.0485	0.030	1.128	3.00	CSRL	120	0.008	123	0.0245	0.0000	**0.0245**
DG water transfer pump suction header - Individual	Pump suction	200	120.0	0.0333	194	0.0485	0.030	1.128	1.50	CSRL	120	0.008	123	0.0122	0.0000	**0.0122**
Pump Discharge	Pump Discharge Header	150	120.0	0.0333	144	0.0360	0.016	2.047	1.50	CSRL	120	0.035	29	0.0522	0.0000	**0.0522**
DG Tank	To DMWST (Rev-02)	200	120.0	0.0333	194	0.0485	0.030	1.128	100.00	CSRL	120	0.008	123	0.8152	0.0000	**0.8152**

FITTING LOSSES

Fittings K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton

PIPE			ID	Bend							Tee		Valve																
FROM	TO	NB mm	K val	Bell mouth	11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
				0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05				
DG water transfer pump suctio	DG water transfer pump suction header -	200	194.00									1																	**0.0648**
DG water transfer pump suctio	Pump suction	200	194.00														1												**0.0156**
Pump Discharge	Pump Discharge Header	150	144.00					1									1				1								**0.5744**
DG Tank	To DMWST (Rev-02)	200	194.00					2				2													10				**0.7713**

Frictional loss (Calculated)			**2.330**
Suction Head	0.000	1.00	**-0.500**
MAXIMUM HEAD LOSS IN THE WBA (pl refer DM plant design software projection)			**6.0**
MAXIMUM HEAD LOSS IN THE SBA (pl refer DM plant design software projection)			**6.0**
MAXIMUM HEAD LOSS IN THE MB (pl refer DM plant design software projection)			**7.0**
Maximum Pipe Ht (static Head)			**12.0**
Total Head in M (Required)			**32.830**
TOTAL HEAD PROVIDED in M			**45**
Margin Available in % (Rev-02)			**36%**

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CLIENT :	M/S. BHEL
Doc. No	PE-V0-408-163-A003

CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL - WANAKBORI
Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

REGENERATION WATER TRANSFER PUMPS - Capacity - 20 m3/hr @ 30 mWC head (Rev-02)

FORMULA'S * $V = 0.849\ C\ R^{0.63}\ S^{0.54}$, Entry Loss = $0.5\ V^2/2g$, Exit Loss = $V^2/2g$ & Fitting Losses = $K \times V^2/2g$ x No. of fittings.

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	Pipe Coeff.	Slope S		Pipe	Entry &	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		C	*	1 in	Loss SxL	Exit loss	m
REGENERATION WATER TRANSFER pump suction header - Common	REGENERATION WATER TRANSFER pump suction header - Individual	100	20.0	0.0056	100	0.0250	0.008	0.707	3.00	CSRL	120	0.007	134	0.0223	0.0000	**0.0223**
REGENERATION WATER TRANSFER pump suction header - Individual	Pump suction	100	20.0	0.0056	100	0.0250	0.008	0.707	1.50	CSRL	120	0.007	134	0.0112	0.0000	**0.0112**
Pump Discharge	Pump Discharge Header	80	20.0	0.0056	80	0.0200	0.005	1.105	1.50	CSRL	120	0.022	45	0.0331	0.0000	**0.0331**
MB	To DMWST	80	20.0	0.0056	80	0.0200	0.005	1.105	100.00	CSRL	120	0.022	45	2.2076	0.0000	**2.2076**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bell mouth	Bend							Tee		Valve									Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
FROM	TO	NB mm	K val		11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot								
				0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05				
REGENERATION WATER TRANSFER pump suction header - Common	REGENERATION WATER TRANSFER pump suction header - Individual	100	100.00									1																		**0.0255**
REGENERATION WATER TRANSFER pump suction header - Individual	Pump suction	100	100.00														1													**0.0061**
Pump Discharge	Pump Discharge Header	80	80.00					1									1				1									**0.1675**
MB	To DMWST	80	80.00					2				2													2					**0.2926**

Frictional loss (Calculated)			**2.766**
Suction Head	0.000	1.00	**-1.000**
MAXIMUM HEAD LOSS IN THE EJECTOR			**5.0**
MAXIMUM HEAD LOSS IN THE VESSEL (MB vessel has maximum, pls refer design software projection)			**7.0**
Maximum Pipe Ht (static Head)			**12.0**
Total Head in M (Required)			**25.766**
TOTAL HEAD PROVIDED in M			**30**
Margin Available in %			**15%**

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CLIENT :	M/S. BHEL
Doc. No	PE-V0-408-163-A003

CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL - WANAKBORI
Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

BACKWASH WASTE WATER DISPOSAL PUMPS - Capacity - 75 m3/hr @ 35 mWC head (Rev-04)

FORMULA'S * $V = 0.849\ C\ R^{0.63}\ S^{0.54}$, Entry Loss = $0.5\ V^2/2g$, Exit Loss = $V^2/2g$ & Fitting Losses = $K \times V^2/2g$ x No. of fittings.

PIPE FROM	PIPE TO	NB mm	Flow Q m^3/hr	Flow Q m^3/sec	Pipe Size ID mm	Hydraulic mean dep. R	Area m^2	Velocity m/sec V	Length mts L	MOC	Pipe Coeff. C	Slope S *	Slope S 1 in	Pipe Loss SxL	Entry & Exit loss	Head loss m
Backwash waste water disposal pump suction header - Common	Backwash waste water disposal pump suction header - Individual	125	75.0	0.0208	125	0.0313	0.012	1.698	3.00	CS	100	0.041	25	0.1221	0.0000	**0.1221**
Backwash waste water disposal pump suction header - Individual	Pump suction	125	75.0	0.0208	125	0.0313	0.012	1.698	1.50	CS	100	0.041	25	0.0611	0.0000	**0.0611**
Pump Discharge	Pump Discharge Header	125	75.0	0.0208	125	0.0313	0.012	1.698	1.50	CS	100	0.041	25	0.0611	0.0000	**0.0611**
Sump	To Stilling Chamber of PT Plant	125	75.0	0.0208	125	0.0313	0.012	1.698	350.00	CS	100	0.041	25	14.2453	0.0000	**14.2453**

FITTING LOSSES

Fittings K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton

PIPE FROM	PIPE TO	NB mm	ID	Bell mouth	Bend 11¼°	Bend 22½°	Bend 45°	Bend 90°	Bend 180°	Bend Square	Bend Miter	Tee Branch	Tee Main	Valve Gate	Valve Globe	Valve Diaph.	Valve Butter	Valve Plug	Valve Ball	Valve Angle	Valve Check	Valve Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
			K val	0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05				
Backwash waste water disposal pump suction header - Common	Backwash waste water disposal pump su	125	125.00									1																		**0.1469**
Backwash waste water disposal pump suction header - Individual	Pump suction	125	125.00														1													**0.0353**
Pump Discharge	Pump Discharge Header	125	125.00					1									1				1										**0.3951**
Sump	To Stilling Chamber of PT Plant	125	125.00					2				2													2	71.2					**1.2133**

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NAME: GAJENDRA SINGH

Frictional loss (Calculated)			**16.280**
Sump Depth	0.000	3.00	**3.000**
Maximum Pipe Ht (static Head)			**12.0**
Total Head in M (Required)			**31.280**
TOTAL HEAD PROVIDED in M			**35 (Rev-04)**
Margin Available in %			**10%**

END USER:	GSECL, 1 X 800 MW WANAKBORI STPP	CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL	CLIENT :	M/S. BHEL - WANAKBORI
Doc. No	PE-V0-408-163-A003	Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

Neutralised effluent disposal pumps - Capacity - 40 m3/hr @ 31 mWC head(Rev-03)

FORMULA'S * $V = 0.849\ C\ R^{0.63}\ S^{0.54}$, Entry Loss = $0.5\ V^2/2g$, Exit Loss = $V^2/2g$ & Fitting Losses = $K \times V^2/2g$ x No. of fittings.

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	Pipe Coeff.	Slope S		Pipe	Entry &	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		C	*	1 in	Loss SxL	Exit loss	m
Neutrailised effulent disposal pump suction header - Common	Neutrailised effulent disposal pump suction header - Individual	100	40.0	0.0111	100	0.0250	0.008	1.415	3.00	MSRL	100	0.038	27	0.1130	0.0000	**0.1130**
Neutrailised effulent disposal pump suction header - Individual	Pump suction	100	40.0	0.0111	100	0.0250	0.008	1.415	1.50	MSRL	100	0.038	27	0.0565	0.0000	**0.0565**
Pump Discharge	Pump Discharge Header	100	40.0	0.0111	100	0.0250	0.008	1.415	1.50	MSRL	100	0.038	27	0.0565	0.0000	**0.0565**
N-Pit	To Guard Pond/CMB (Rev-03)	150	80.0	0.0222	150	0.0375	0.018	1.258	800.00	MSRL	100	0.019	53	15.0993	0.0000	**15.0993**

FITTING LOSSES

Fittings K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton

PIPE			ID	Bell mouth	Bend							Tee		Valve															
FROM	TO	NB mm	K val	0.10	11¼° 0.10	22½° 0.20	45° 0.35	90° 0.45	180° 1.50	Square 0.40	Miter 0.17	Branch 1.00	Main 0.40	Gate 0.17	Globe 6.00	Diaph. 2.60	Butter 0.24	Plug 9.00	Ball 0.30	Angle 2.00	Check 2.00	Foot 15.0	Exp / Reducer 0.60	Y/ strainer 3.00	Miscellaneous 0.90	welding loss 0.05				
Neutrailised effulent disposal pump suction header -	Neutrailised effulent disposal pump sucti	100	100.00									1																	**0.1020**
Neutrailised effulent disposal pump suction header - Individual	Pump suction	100	100.00														1												**0.0245**
Pump Discharge	Pump Discharge Header	100	100.00					1									1				1								**0.2744**
N-Pit	To Guard Pond/CMB (Rev-03)	150	150.00					2				2												2					**0.3788**

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT.

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DEPARTMENT: MECHANICAL AUXILIARY

NAME: GAJENDRA SINGH

Frictional loss (Calculated)	**16.105**
Maximum Pipe Ht (static Head)	**12.0**
Total Head in M (Required)	**28.105**
TOTAL HEAD PROVIDED in M	**31**
Margin Available in %	**10%**

END USER:	GSECL, 1 X 800 MW WANAKBORI STPP	CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL	CLIENT :	M/S. BHEL - WANAKBORI
Doc. No	PE-V0-408-163-A003	Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

Air blower for DMF - Capacity - 480 m3/hr @ 4000 mmWC head

FORMULA'S Head loss (P/L) = pv^2u/2d, **& Fitting Losses = K x $\rho V^2/2g$ x No. of fittings.**

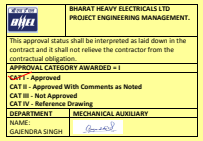
PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	friction loss coefficient	P/L		Pipe Loss	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		u	N/m2	m	P/L*L	mm
Air blower for DMF suction header - Common	Air blower for DMF suction header - Individual	NA													
Air blower for DMF suction header - Individual	Blower suction														
Blower Discharge	Blower Discharge Header	100	480.0	0.1333	100	0.1000	0.008	16.977	1.50	GI	0.02	34.584	0.003	0.0052	**5.1876**
Blower Discharge Header	To DMF	100	480.0	0.1333	100	0.1000	0.008	16.977	30.00	GI	0.02	34.584	0.003	0.1038	**103.7529**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bell mouth	Bend							Tee		Valve															
					11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
FROM	TO	NB mm	K val	0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05				
Air blower for DMF suction header - Common	Air blower for DMF suction header - Indiv	NA										1																	**0.0000**
Air blower for DMF suction header - Individual	Blower suction																1												**0.0000**
Blower Discharge	Blower Discharge Header	100	100.00					1									1				1								**4.7417**
Blower Discharge Header	To DMF	100	100.00					2				2												2					**8.2847**

Frictional loss (Calculated)	**121.967**
Static head = 12 m above ground level = 12*density of air*1000/1000 mm	**14.4**
Maximum head loss in DMF	**2500.0**
Total Head in M (Required)	**2636.367**
TOTAL HEAD PROVIDED in M	**4000**
Margin Available in %	**52%**



END USER:	GSECL, 1 X 800 MW WANAKBORI STPP	CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL	CLIENT :	M/S. BHEL - WANAKBORI
Doc. No	PE-V0-408-163-A003	Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

Air blower for Degasser - Capacity - 3150 m3/hr @ 100 mmWC head (Rev-02)

FORMULA'S Head loss (P/L) = pv^2u/2d, **& Fitting Losses = K x $\rho V^2/2g$ x No. of fittings.**

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	friction loss coefficient	P/L		Pipe Loss	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		u	N/m2	m	P/L*L	mm
Air blower for Degasser suction header - Common	Air blower for Degasser suction header - Individual	NA													
Air blower for Degasser suction header - Individual	Blower suction														
Blower Discharge	Blower Discharge Header	250	3150.0	0.8750	250	0.2500	0.049	17.825	1.50	GI	0.01	7.626	0.001	0.0011	**1.1439**
Blower Discharge Header	To Degasser Tower	250	3150.0	0.8750	250	0.2500	0.049	17.825	50.00	GI	0.01	7.626	0.001	0.0381	**38.1292**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bend							Tee		Valve																
FROM	TO	NB mm	K val	Bell mouth	11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss				
				0.10	0.10	0.20	0.35	0.25	1.50	0.40	0.17	0.30	0.40	0.17	6.00	2.60	0.24	9.00	0.30	1.00	0.50	15.0	0.60	3.00	0.90	0.05				
Air blower for Degasser suction header - Common	Air blower for Degasser suction header -	NA										1																	**0.0000**
Air blower for Degasser suction header - Individual	Blower suction																1												**0.0000**
Blower Discharge	Blower Discharge Header	250	250.00					1									1				1								**1.9239**
Blower Discharge Header	To Degasser Tower	250	250.00					1																					**0.4858**

Frictional loss (Calculated)	**41.683**
Static head = 8 m above ground level = 9.81*density of air*1000/1000 mm	**7.2**
Total Head in M (Required)	**48.883**
TOTAL HEAD PROVIDED in M	**100**
Margin Available in %	**105%**

BHARAT HEAVY ELECTRICALS LTD
PROJECT ENGINEERING MANAGEMENT:
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CAT IV - Reference Drawing
DEPARTMENT: MECHANICAL AUXILIARY
NAME: GAJENDRA SINGH

END USER:	GSECL, 1 X 800 MW WANAKBORI STPP	CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL	CLIENT :	M/S. BHEL - WANAKBORI
Doc. No	PE-V0-408-163-A003	Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

Air blower for MB & NPIT - Capacity - 700 m3/hr @ 4000 mmWC head (Rev-03)

FORMULA'S Head loss (P/L) = pv^2u/2d, **& Fitting Losses = K x $\rho V^2/2g$ x No. of fittings.**

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	friction loss coefficient	P/L		Pipe Loss	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		u	N/m2	m	P/L*L	mm
Air blower for MB suction header - Common	Air blower for MB suction header - Individual	NA													
Air blower for MB suction header - Individual	Blower suction														
Blower Discharge	Blower Discharge Header	100	450.0	0.1250	100	0.1000	0.008	15.915	1.50	GI	0.02	30.396	0.003	0.0046	**4.5595**
Blower Discharge Header	To MB and N-Pit	100	450.0	0.1250	100	0.1000	0.008	15.915	15.00	GI	0.02	30.396	0.003	0.0456	**45.5945**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bell mouth	Bend							Tee		Valve																
					11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss					
FROM	TO	NB mm	K val	0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05				
Air blower for MB suction header - Common	Air blower for MB suction header - Individ	NA	0.00									1																		**0.0000**
Air blower for MB suction header - Individual	Blower suction	0	0.00														1													**0.0000**
Blower Discharge	Blower Discharge Header	100	100.00					1									1				1									**4.1675**
Blower Discharge Header	To MB and N-Pit	100	100.00					2				2													2					**7.2815**

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NAME: GAJENDRA SINGH

Frictional loss (Calculated)	**61.603**
Static head = 12 m above ground level = 12*density of air*1000/1000 mm	**14.4**
Maximum head loss in MB	**3000.0**
Total Head in M (Required)	**3076.003**
TOTAL HEAD PROVIDED in M	**4000**
Margin Available in %	**30%**

END USER:	GSECL, 1 X 800 MW WANAKBORI STPP
CLIENT :	M/S. BHEL
Doc. No	PE-V0-408-163-A003

CONTRACTOR:	AQUADESIGNS INDIA PVT.LTD
CLIENT :	M/S. BHEL - WANAKBORI
Doc. Name	Pressure drop calculation

PROJECT : DM PLANT PACKAGE

TITLE : HYDRAULIC CALCULATION FOR

Air blower for DMF- potable - Capacity - 62 m3/hr @ 4000 mmWC head (Rev-03)

FORMULA'S Head loss (P/L) = pv^2u/2d, **& Fitting Losses = K x ρV²/2g x No. of fittings.**

PIPE			Flow Q		Pipe Size	Hydraulic	Area	Velocity	Length	MOC	friction loss coefficient	P/L		Pipe Loss	Head loss
FROM	TO	NB mm	m^3/hr	m^3/sec	ID mm	mean dep. R	m^2	m/sec V	mts L		u	N/m2	m	P/L*L	mm
Air blower for DMF- potable suction header - Common	Air blower for DMF- potable suction header - Individual	NA													
Air blower for DMF- potable suction header - Individual	Blower suction														
Blower Discharge	Blower Discharge Header	40	62.0	0.0172	40	0.0400	0.001	13.705	1.50	GI	0.02	56.348	0.006	0.0085	**8.4522**
Blower Discharge Header	To DMF	40	62.0	0.0172	40	0.0400	0.001	13.705	10.00	GI	0.02	56.348	0.006	0.0563	**56.3482**

FITTING LOSSES

Fittings **K - values are taken from Chemical Engineers Hand Book - By Robert H. Perry /Cecil H Chilton**

PIPE			ID	Bell mouth	Bend							Tee		Valve																
FROM	TO	NB mm	K val		11¼°	22½°	45°	90°	180°	Square	Miter	Branch	Main	Gate	Globe	Diaph.	Butter	Plug	Ball	Angle	Check	Foot	Exp / Reducer	Y/ strainer	Miscellaneous	welding loss					
				0.10	0.10	0.20	0.35	0.45	1.50	0.40	0.17	1.00	0.40	0.17	6.00	2.60	0.24	9.00	0.30	2.00	2.00	15.0	0.60	3.00	0.90	0.05					
Air blower for DMF- potable suction header - Common	Air blower for DMF- potable suction head	NA	0.00									1																		**0.0000**
Air blower for DMF- potable suction header - Individual	Blower suction	0	0.00														1													**0.0000**
Blower Discharge	Blower Discharge Header	40	40.00					1									1				1									**3.0902**
Blower Discharge Header	To DMF	40	40.00					2				2													2					**5.3993**

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Frictional loss (Calculated)	**73.290**
Static head = 12 m above ground level = 12*density of air*1000/1000 mm	**14.4**
Maximum head loss in DMF- potable	**2500.0**
Total Head in M (Required)	**2587.690**
TOTAL HEAD PROVIDED in M	**4000(Rev-04)**
Margin Available in %	**55%**

Chapter 9 BATTERY LIMITS

BATTERY LIMITS FOR DEMINERALISATION PLANT:

S.NO	DESCRIPTION	TERMINATION POINT BY ADIPL
1.	DM Feed Water	From Clarified Water Pump House to DM plant (Max 200 meter distance from DM plant Area)
2.	Treated Water	Upto 5 m from the DM plant building.
3.	Backwash Waste Water	To Stilling Chamber of Pre Treatment Plant (Max 350 Meter distance from DM plant area)
4.	Neutralized Effluent	To Central Monitoring Basin (Max 800 meter distance from DM plant area)
S.NO	**DESCRIPTION**	**TERMINATION POINT BY CLIENT**
1.	Instrument air	25 NB Instrument Air Supply at 5-7 Kg/Cm2-At 5 meter distance from DM plant area
2.	Service Area	25 NB Instrument Air Supply at 5-7 Kg/Cm2-At 5 meter distance from DM plant area
3.	Power supply	415V , 50 Hz, 3 Phase Supply at Motor Terminals
4.	Service Water	50 NB connection to be provided at 5 meter distance from DM plant area
5.	Drinking Water	25 NB connection to be provided at 5 meter distance from DM plant area
6.	Chemicals	20 m hose from unloading pumps.

BATTERY LIMITS FOR POTABLE WATER PLANT:

S.NO	DESCRIPTION	TERMINATION POINT BY ADIPL
1.	Filter Feed Water	50 NB Pipe Connection to be provided At 5 meter distance from DMF inlet
2.	Treated Water	50 NB connection to be provided at 5 meter distance from Potable plant area
3.	Backwash Waste Water	To Filter Backwash Sump
S.NO	**DESCRIPTION**	**TERMINATION POINT BY CLIENT**
1.	Instrument air	25 NB Instrument Air Supply at 5-7 Kg/Cm2-At 5 meter distance from Potable plant area
2.	Service Air	25 NB Instrument Air Supply at 5-7 Kg/Cm2-At 5 meter distance from Potable plant area
3.	Power supply	415V , 50 Hz, 3 Phase Supply at Motor Terminals
4.	Service Water	50 NB connection to be provided at 5 meter distance from Potable plant area
5.	Chemicals	At the inlet of dosing tanks

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CAT IV - Reference Drawing

DEPARTMENT	MECHANICAL AUXILIARY
NAME: GAJENDRA SINGH	

Chapter 10 ANNEXURE-1

1. DM PLANT DESIGN SOFTWARE PROJECTION
2. MB PLANT DESIGN SOFTWARE PROJECTION

	BHARAT HEAVY ELECTRICALS LTD PROJECT ENGINEERING MANAGEMENT.
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CAT I - Approved CAT II - Approved With Comments as Noted CAT III - Not Approved CAT IV - Reference Drawing	
DEPARTMENT	MECHANICAL AUXILIARY
NAME : GAJENDRA SINGH	

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CALCULATION OF ION EXCHANGE PLANT WITH PUROLITE ION EXCHANGE RESINS

Customer	BHEL-wankbori	**Operator**	Operator
Sales Person	Praveen	**Agent**	Agent
OEM Company	ADIPL	**Date**	9-10-2016
Calcn. No	No	**Code**	NONAME

1. INFLUENT WATER SPECIFICATIONS

1.1. Origin: River
1.2. Pretreatment: filtration

1.3. Water analysis:

Ca, ppm CaCO3	85.00	**HCO3**, ppm CaCO3	160.00	**CO2**, meq/l	0.0000
Mg, ppm CaCO3	94.00	**CO3**, meq/l		**SiO2**, ppm	22.0000
Na, ppm CaCO3	75.00	**Cl**, ppm CaCO3	52.00	**Temperature**, °C	10
K, meq/l		**SO4**, ppm CaCO3	20.00	**Org.**, mg/l KMnO4	
Fe, ppm	0.0500	**NO3**, ppm CaCO3	22.00		
T.C., meq/l	5.0827	**T.A.**, meq/l	5.0800		

2. DESIGN INPUT DATA

2.1. Flow rate per line, m3/h: 106.83
2.2. Running time, h: 18.0
2.3. Net run, m3: 1922.94

3. TREATED WATER QUALITY

	achieved
Conductivity, µS/cm:	<5 at 25 °Cat theoutlet of SBA
Silica leakage, ppm SiO2:	<0.1 at the outlet of SBA
Sodium leakage, ppm CaCO3:	<1 at outlet of SAC
Hardness leakage	Not detectable at the outlet of SAC

Residual CO2:	after SAC filter, meq/l	3.2000
	after degasser, ppm as CO2	< 5 at the outlet of degasser tower

4. PUROLITE IX PROCESS OPTIONS

4.1. Ion exchange process: Demineralisation
4.2. Plant layout: WAC -> SAC -> DEG -> WBA -> SBA
No of Lines: _____
4.3. Resins chosen: PUROLITE C-104Plus, PurofinePFC-100H, Purolite A-100Plus, PuropackPPA-500Plus

5. COMMENTS

Purolite®

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6. FULL PLANT DESIGN DETAILS				Project: BHEL
6.1. Filter	**WAC**	**SAC**	**WBA**	**SBA**
6.2. IX Load				
Gross flow , m3/hr	112.26	111.28	108.55	107.57
Gross run load, m3	2020.6	2003.0	1953.8	1936.2
Ionic load, eq	5496.16	4730.60	2938.54	1825.20
Overrun, %		15		20
6.3. Resin Data				
Resin type	C-104 Plus	PFC-100H	A-100 Plus	PPA-500 Plus
Resin grade	Std	Pfn	Std	Pfn
Theor. capacity, eq/l	1.94	1.62	1.11	0.490
Oper. capacity, eq/l	1.746	1.458	0.999	0.441
Resin volume, l	3150	3245	2945	4140
Flow rate, BV/h	33.4	32.4	35.7	25.4
Organic load, g/l			0.000	0.000
6.4. Regeneration Data				
Regeneration Mode	CF	CTF:Pfn	CF	CTF:Pfn
Regenerant	HCl	HCl	NaOH	NaOH
Concentration, %		5.0		5.0
% of Theory	140	263	255	510
for W-S Pair	122		214	
Level, g/l		140.0		90.0
Total, kg		454.3		372.6
Excess, eq		2221		4551
Temperature, °C			25	25
Chemical at 30 % conc, m3		1.34		0.96
Backwash m3	4.25		2.36	
Downflow water		5.08		5.83
Dilution water, m3	11.65	7.40	10.03	6.57
Bed warming m3				4.14
Slow rinse, m3	8.65	6.49	5.52	4.14
Fast rinse, m3	12.60		11.78	
Backwash for MB m3	2.98			
6.5. Plant Size Data				
Bed depth, mm (changing from supplied form as shown)				
Supplied form	1121	1156	1048	1474
Exhausted form	1290		1257	
Regenerated form		1248		1740
Vessel diameter, mm	1900	1900	1900	1900
Cross-section, m2	2.81	2.81	2.81	2.81
Cylindrical height, mm	2100	2400	2100	3300
6.6. Hydraulic Data				
Linear velocity, m/h	39.99	39.6	38.7	38.3
Pressure Drop, kPa	37.7	28.1	34.0	32.1
6.7. Design Factor	0.90	0.90	0.90	0.90

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CALCULATION OF ION EXCHANGE PLANT WITH PUROLITE ION EXCHANGE RESINS

Customer	BHEL – wankbori – MB	**Operator**	Operator
Sales Person	Praveen	**Agent**	Agent
OEM Company	Aquadesign	**Date**	9-10-2016
Calcn. No	No	**Code**	NONAME

1. INFLUENT WATER SPECIFICATIONS

1.1. Origin: River
1.2. Pretreatment: Filter

1.3. Water analysis:

Ca, ppm CaCO3		**HCO3**, ppm CaCO3		**CO2**, ppm CaCO3	0.0000
Mg, ppm CaCO3		**CO3**, ppm CaCO3		**SiO2**, ppm	0.1000
Na, ppm CaCO3	1.00	**Cl**, ppm CaCO3	1.00	**Temperature**, °C	10
T.C., meq/l	0.0200	**T.A.**, meq/l	0.0200		

2. DESIGN INPUT DATA

2.1. NetFlow rate per line, m3/h: 105.0
2.2. Running time, h: 126.0
2.3. Net run, m3: 13230.0

3. TREATED WATER QUALITY

	achieved
Conductivity, µS/cm:	<0.10 at 25 °C
Silica leakage, ppb SiO2:	<10
Iron as Fe	Nil
Free CO2 ppm as CO2	Nil
Total Hardness	Nil
Total Electrolyte ppm	0.1 Max
pH value	6.8 -7.2 at 25 °C

4. PUROLITE IX PROCESS OPTIONS

4.1. Ion exchange process: Working Mixed Bed
4.2. Plant layout: SAC+SBA (Working MB)
No of Lines: _____
4.3. Resins chosen: PUROLITE PurofinePFC-100HPuropackPPA-500Plus
4.4. Volume ratio: Free selection

5. COMMENTS

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6. FULL PLANT DESIGN DETAILS		Project: BHEL
6.1. Filter	SAC	SBA
	(common)	
6.2. IX Load		
Gross flow, m3/hr	106.83	
Gross run load, m3	13460.1	
Ionic load, eq	269	292
6.3. Resin Data		
Resin type	C-100	A-400
Resin grade	PFC100H	PFA500 Plus
Theor. capacity, eq/l	1.32	0.35
Oper. capacity, eq/l	0.270	0.292
Resin volume, l	1000	1000
Flow rate, BV/h	53.4	
SAC %	50.00	
6.4. Regeneration Data		
Regeneration Mode	Internal	
Regenerant	HCl	NaOH
Concentration, %	5	5
% of Theory	1018	940
Level, g/l	100.0	100.0
Total, kg	100	100
Excess, eq	2471	2208
Temperature, °C		25
Chemical at 30 % conc, m3	0.29	0.26
Backwash m3	2.98	
Dilution water, m3	1.63	1.65
Bed warming, m3		1.00
Slow rinse, m3	3.00	2.00
Fast rinse, m3	4.00	4.00
Water required for WBA and SBA regeneration	30.40	
6.5. Plant Size Data		
Bed depth, mm (changing from supplied form as shown)		
Supplied form	503	503
Exhausted form		
Regenerated form	544	594
Vessel diameter, mm	1600	
Cross-section, m2	1.99	
Cylindrical height, mm	2400.00	
6.6. Hydraulic Data		
Linear velocity, m/h	53.8	
Pressure Drop, kPa	46.0	
6.7. Design Factor	0.205	0.835

Chapter 11

ANNEXURE-2

Table No.-A-2.1

N-PIT – sizing calculation and Regeneration flow and timing details

Table No.-A-2.1

N-Pit sizing Calculations

Wastes Generated	WAC				SAC				WBA				SBA				MB-Cation		MB-Anion		MB flow details	
	Vol in m3	Source of water	Flow in m3/hr	Regeneration time in min	Vol in m3	Source of water	Flow in m3/hr	Regeneration time in min	Vol in m3	Source of water	Flow in m3/hr	Regeneration time in min	Vol in m3	Source of water	Flow in m3/hr	Regeneration time in min	Vol in m3	Source of water	Vol in m3	Source of water	Flow in m3/hr	Regeneration time in min
Backwash Waste	4.25	ACF	25.5	10	-	-	-	-	2.36	DG	14.16	10	-	-	-	-	3	SBA	-	-	18	10
Bed settle	-	-	-	5	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	5
Downflow water	-	-	-	-	5.06	WAC	3.37	90	-	-	-	-	5.83	WBA	3.89	90	-	-	-	-	-	-
Chemical at 30% concerntration in measuring tank	-	-	-	-	1.34	Acid	11.65	45	-	-	-	-	0.75	Alkali	9.76	45	0.29	Acid	0.26	Alkali	2.54	45
Dilution Water (chemical injection)	11.65	DG	31.07	45	7.40	DG			10.03	DM	27.30	45	6.57	DM			1.63	DM	1.65	DM		
Bed warming	-	-	-	-	-	-	-	-	-	-	-	-	4.14	DM	16.56	15	-	-	1	DM	4	15
Slow Rinse	8.65	DG	23.07	45	6.49	DG	8.65	45	5.52	DM	24.33	45	4.14	DM	8.28	30	3	DM	2	DM	6.7	45
Drain down	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Air scouring	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	241.2	10
Refilling	-	-	112.26	5	-	-	111.28	5	-	-	108.55	5	-	-	107.57	5	-	-	-	-	105.2	5
Fast Rinse	12.6	ACF	112.26	6.73	12.6	WAC	111.28	6.79	11.78	DG	108.55	6.51	11.78	WBA	107.57	6.57	4	SBA	4	SBA	105.2	4.56
Total time				111.7				96.8				116.5				96.6						144.6
Total Regeneration Waste Generated	**24.55**				**32.89**				**17.91**				**33.21**				**11.92**		**8.90**			
Total N-Pit capacity Required with 20% margin (in m3)	**155**																					

Note :

1.The flow rate marked in yellow includes the recycling flow from SAC and SBA and volume marked in green includes recycling flow from WAC and WBA, hence it is included in the total regenaeration waste of SAC and SBA, not in WAC and WBA.

2. The waste generation includes only common fast rinse for WAC& SAC and WBA &SBA.

Table No.-A-2.2

DG Tank Capacity Calculations (Please refer annexure – 1 for the below data and also Table No.- A-2.1)	
Wastes Generated	**m3**
WAC Slow Rinse Waste	8.65(Rev-03)
WAC Dilution Water(Rev-01)	11.65(Rev-03)
SAC Dilution Water	7.40(Rev-03)
SAC Slow Rinse Waste	6.49(Rev-03)
WBA Backwash Water	2.36
WBA Fast Rinse Waste	11.78(Rev-03)
Total Degassed Water Required for Regeneration of WAC, WBA and SAC	=(8.65+11.65+7.40+6.49+2.36 +11.78) =48.33(Rev-03)
One hour retention for the DM chain	=105 m3
Capacity required for DG water tank	153.33 m3(Rev-03)
DG Tank capacity provided with 20% margin	**184 m3**(Rev-03)

Table No.-A-2.3

Horizontal tank volume arrival calculation

DG water storage tank dimension arrival calculation		
Diameter of tank including rubber lining	4.791	m
Radius of tank including rubber lining	2.3955	m
LOS of the tank	9	m
Free board	0.3	m
Dead Depth	0.1	m
Shell Area	18.01863959	Sq.m
Effective area	Shell area - Arc1 area + Area of the triangle1 - Arc2 area + Area of the triangle2	Sq.m
Arc1 area	Angle of arc1*(radius)^2/2	Sq.m
Angle of arc1	2*COS-1(Ht of triangle1/Radius)	
Height of the traingle 1	Radius - Free board	
	2.0955	m
Angle of arc1	1.01169066	
Arc area1	2.902753086	Sq.m
Area of triangle1	2* (Area of right angle traingle1)	Sq.m
Area of right angle triangle1	(breadth* Height)/2	Sq.m
Breadth of the right angle traingle1	1.161	By pythagoras thorem
Area of right angle triangle 1	1.216157506	
Area of triangle1	2.432315011	Sq.m
Arc2 area	Angle of arc2*(radius)^2/2	Sq.m
Angle of arc2	2*COS-1(Ht of triangle2/Radius)	
Height of the traingle 2	Radius - Dead depth	
	2.2955	
Angle of arc2	0.579921758	Sq.m
Arc area2	1.663917379	
Area of triangle2	2* (Area of right angle traingle2)	Sq.m
Area of right angle triangle2	(breadth* Height)/2	
Breadth of right angle traingle2	0.685	m (By pythagoras thorem)
Area of right angle triangle 2	0.786104021	Sq.m
Area of triangle2	1.572208043	Sq.m
Effective area	17.45649217	Sq.m

Effective volume of the shell	Effective area*LOS	Cu.m
Effective volume of the shell	157.1084296	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	
Effective Volume of bottom quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/(3*R3^2)))	Cu.m
R1	2.3955	m
R2	1.1955	m
R3	2.3955	m
a	R3 - Dead depth	m
	2.2955	m
Effective Volume of bottom quadrants for ellipsoidal dish	14.3238394	Cu.m
Effective Volume of top quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/3*R3^2))/2	Cu.m
R1	2.3955	m
R2	1.19775	m
R3	2.3955	m
a	R3 - free board	m
	2.0955	m
Effective Volume of top quadrants for ellipsoidal dish	14.06352956	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	Cu.m
Effective Volume of dish	28.38736896	Cu.m
Effective Volume of Horizontal storage tank	Effective volume of the Shell + Effective volume of dish	
Effective Volume of Horizontal storage tank	185.4957985	Cu.m
Our required volume	185	Cu.m

Bulk acid storage tank dimension arrival calculation		
Diameter of tank including rubber lining	3.191	m
Radius of tank including rubber lining	1.5955	m
LOS of the tank	6.3	m
Free board	0.3	m
Dead Depth	0.1	m
Shell Area	7.993247585	Sq.m

Effective area	Shell area - Arc1 area + Area of the triangle1 - Arc2 area + Area of the triangle2	Sq.m
Arc1 area	Angle of arc1*(radius)^2/2	Sq.m
Angle of arc1	2*COS-1(Ht of triangle1/Radius)	
Height of the traingle 1	Radius - Free board	
	1.2955	m
Angle of arc1	1.246550124	
Arc area1	1.58662162	Sq.m
Area of triangle1	2* (Area of right angle traingle1)	Sq.m
Area of right angle triangle1	(breadth* Height)/2	Sq.m
Breadth of the right angle traingle1	0.931	By pythagoras thorem
Area of right angle triangle 1	0.603242727	
Area of triangle1	1.206485455	Sq.m
Arc2 area	Angle of arc2*(radius)^2/2	Sq.m
Angle of arc2	2*COS-1(Ht of triangle2/Radius)	
Height of the traingle 2	Radius - Dead depth	
	1.4955	
Angle of arc2	0.711854842	Sq.m
Arc area2	0.906056051	
Area of triangle2	2* (Area of right angle traingle2)	Sq.m
Area of right angle triangle2	(breadth* Height)/2	
Breadth of right angle traingle2	0.556	m (By pythagoras thorem)
Area of right angle triangle 2	0.415724792	Sq.m
Area of triangle2	0.831449583	Sq.m
Effective area	7.538504952	Sq.m
Effective volume of the shell	Effective area*LOS	Cu.m
Effective volume of the shell	47.4925812	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	
Effective Volume of bottom quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/(3*R3^2)))	Cu.m
R1	1.5955	m
R2	0.7455	m
R3	1.5955	m
a	R3 - Dead depth	m
	1.4955	m
Effective Volume of bottom quadrants for ellipsoidal dish	3.949724406	Cu.m
Effective Volume of top quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/3*R3^2))/2	Cu.m

R1	1.5955	m
R2	0.79775	m
R3	1.5955	m
a	R3 - free board	m
	1.2955	m
Effective Volume of top quadrants for ellipsoidal dish	4.039761357	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	Cu.m
Effective Volume of dish	7.989485764	Cu.m
Effective Volume of Horizontal storage tank	Effective volume of the Shell + Effective volume of dish	
Effective Volume of Horizontal storage tank	55.48206696	Cu.m
Our required volume	54.8	Cu.m

Bulk caustic storage tank dimension arrival calculation		
Diameter of tank including rubber lining	2.291	m
Radius of tank including rubber lining	1.1455	m
LOS of the tank	4.2	m
Free board	0.3	m
Dead Depth	0.1	m
Shell Area	4.120214585	Sq.m
Effective area	Shell area - Arc1 area + Area of the triangle1 - Arc2 area + Area of the triangle2	Sq.m
Arc1 area	Angle of arc1*(radius)^2/2	Sq.m
Angle of arc1	2*COS-1(Ht of triangle1/Radius)	
Height of the traingle 1	Radius - Free board	
	0.8455	m
Angle of arc1	1.481076161	
Arc area1	0.971712038	Sq.m
Area of triangle1	2* (Area of right angle traingle1)	Sq.m
Area of right angle triangle1	(breadth* Height)/2	Sq.m
Breadth of the right angle traingle1	0.773	By pythagoras thorem
Area of right angle triangle 1	0.326723124	
Area of triangle1	0.653446249	Sq.m
Arc2 area	Angle of arc2*(radius)^2/2	Sq.m
Angle of arc2	2*COS-1(Ht of triangle2/Radius)	

Height of the traingle 2	Radius - Dead depth	
	1.0455	
Angle of arc2	0.841896471	Sq.m
Arc area2	0.552355751	
Area of triangle2	2* (Area of right angle traingle2)	Sq.m
Area of right angle triangle2	(breadth* Height)/2	
Breadth of right angle traingle2	0.468	m (By pythagoras thorem)
Area of right angle triangle 2	0.244689442	Sq.m
Area of triangle2	0.489378884	Sq.m
Effective area	3.738971928	Sq.m
Effective volume of the shell	Effective area*LOS	Cu.m
Effective volume of the shell	15.7036821	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	
Effective Volume of bottom quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/(3*R3^2)))	Cu.m
R1	1.1455	m
R2	0.5455	m
R3	1.1455	m
a	R3 - Dead depth	m
	1.0455	m
Effective Volume of bottom quadrants for ellipsoidal dish	1.481754439	Cu.m
Effective Volume of top quadrants for ellipsoidal dish	(3.14*R1*R2*(a-(a^3/3*R3^2))/2	Cu.m
R1	1.1455	m
R2	0.57275	m
R3	1.1455	m
a	R3 - free board	m
	0.8455	m
Effective Volume of top quadrants for ellipsoidal dish	1.425506119	Cu.m
Effective Volume of dish	volume of bottom quadrants + volume of top quadrants	Cu.m
Effective Volume of dish	2.907260558	Cu.m
Effective Volume of Horizontal storage tank	Effective volume of the Shell + Effective volume of dish	
Effective Volume of Horizontal storage tank	18.61094266	Cu.m
Our required volume	18.44	Cu.m