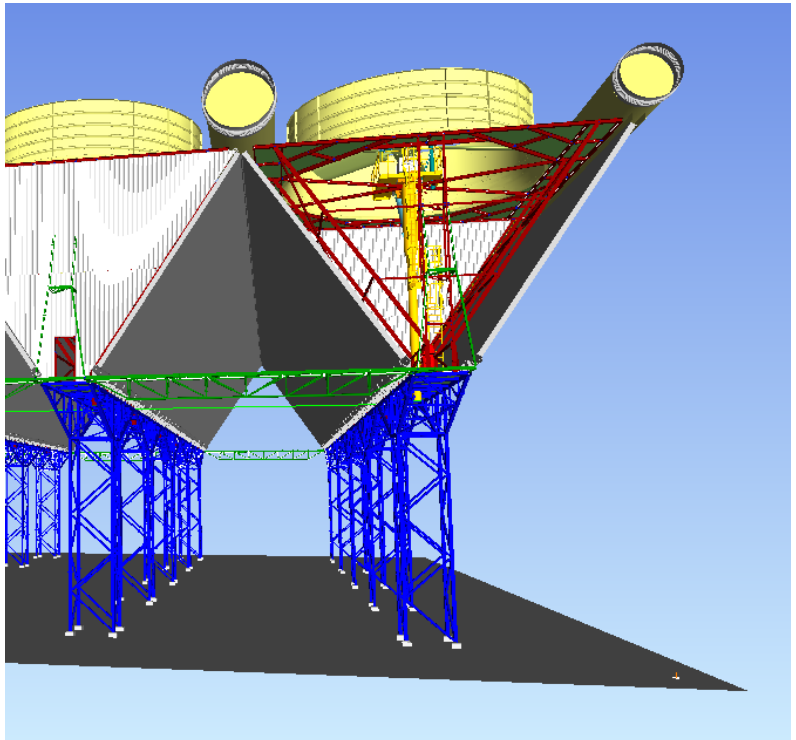
CPV Towantic Energy Center

INDUCED DRAFT AIR-COOLED CONDENSER

Introduction

- CPV Towantic's ACC is a "W" style, induced draft ACC.
- Comprised of six streets with five fan modules each.
- Contains eighteen Condenser sections and twelve Dephlegmator sections.
- Steam Isolations are located on streets 1, 5, and 6.



Advantages of Induced Draft over classic acc

Operational Advantages

- Less vibration stress due to elimination of fan bridge
  $\Rightarrow$ Longer lifetime for gearboxes and fans
- Less sensitive to wind effects
- Less hot air recirculation
- Reduced auxiliary power is possible due to lower pressure drop on air side
- Higher flexibility of sectionalizing (part load operation), if required

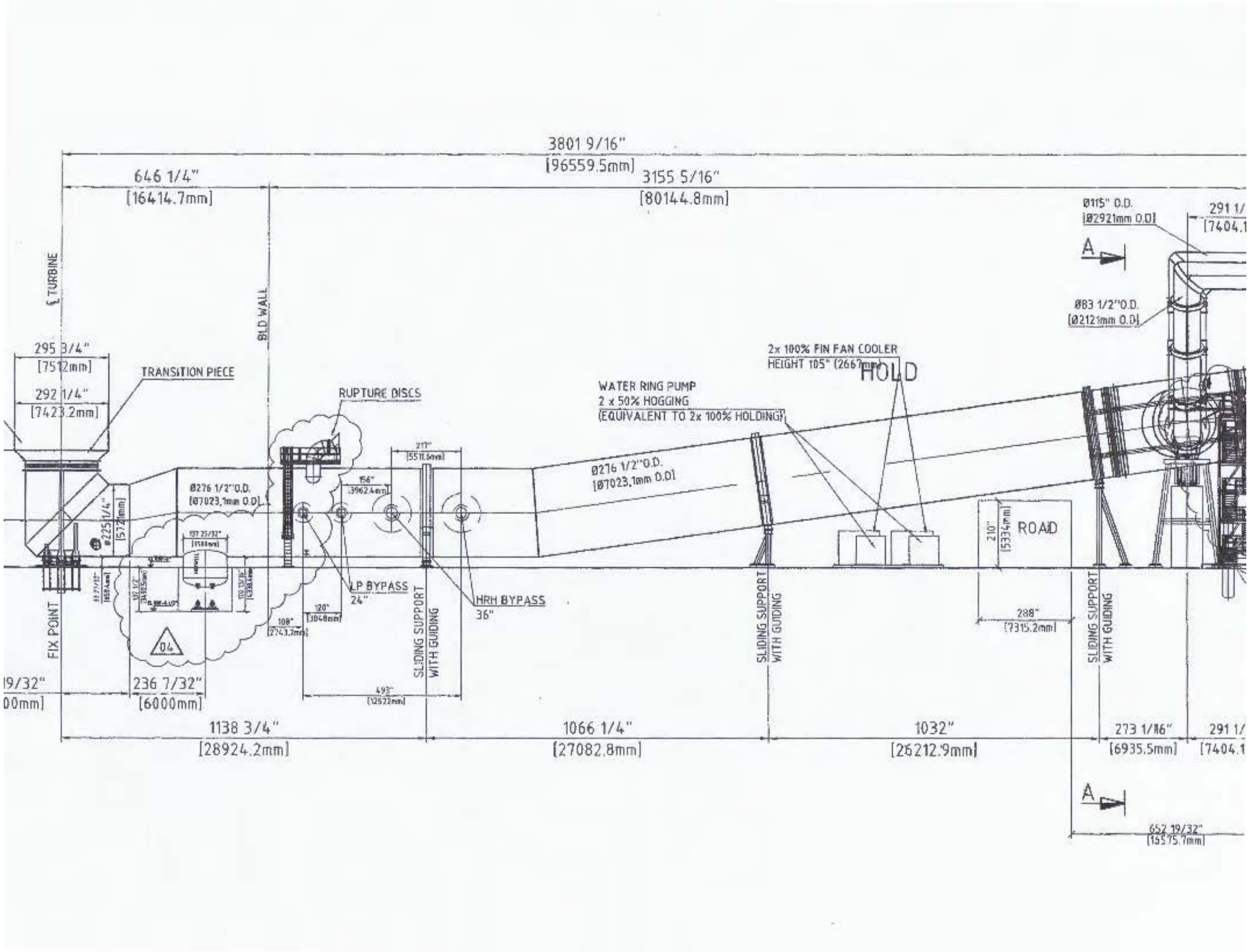
Other Advantages

- Reduced total height of ACC, visual impact
- Smaller footprint of columns
- Lower initial cost over traditional ACCs

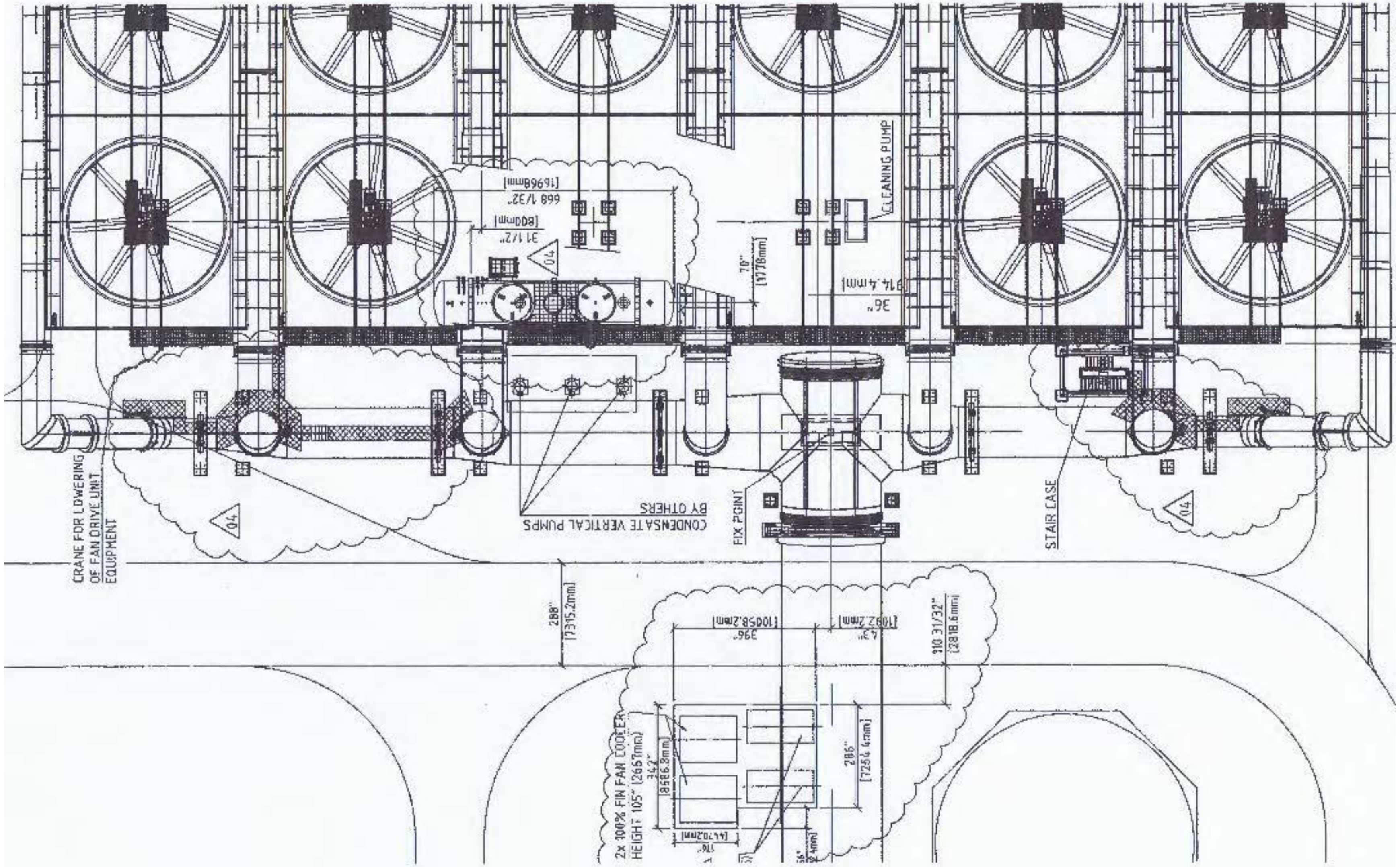
MAIN STEAM DUCT ARRANGMENT

CPV Towantic main steam duct

- All-welded construction in order to ensure leak tightness
- Expansion joints allow for unhampered thermal expansion.



3801 9/16"
[96559.5mm]
646 1/4"
[16414.7mm]
3155 5/16"
[80144.8mm]
Ø115" O.D.
[Ø2921mm O.D]
291 1/
[7404.1
℄ TURBINE
BLD WALL
Ø83 1/2"O.D.
[Ø2121mm O.D]
295 3/4"
[7512mm]
TRANSITION PIECE
292 1/4"
[7423.2mm]
2x 100% FIN FAN COOLER
HEIGHT 105" (2667mm)
HOLD
WATER RING PUMP
2 x 50% HOGGING
(EQUIVALENT TO 2x 100% HOLDING)
RUPTURE DISCS
Ø276 1/2"O.D.
[Ø7023.1mm O.D]
Ø225 1/4"
[5720mm]
210"
[5334mm]
ROAD
LP BYPASS
24"
HRH BYPASS
36"
FIX POINT
SLIDING SUPPORT WITH GUIDING
288"
[7315.2mm]
9/32"
00mm]
236 7/32"
[6000mm]
1138 3/4"
[28924.2mm]
1066 1/4"
[27082.8mm]
1032"
[26212.9mm]
273 1/16"
[6935.5mm]
A
652 19/32"
[15575.7mm]



CLEANING PUMP
CRANE FOR LOWERING OF FAN DRIVE UNIT EQUIPMENT
CONDENSATE VERTICAL PUMPS BY OTHERS
FIX POINT
STAIR CASE
2x 100% FIN FAN COOLER HEIGHT 105" (2667mm)


2017/07/27

ACC Duct Expansion Joints

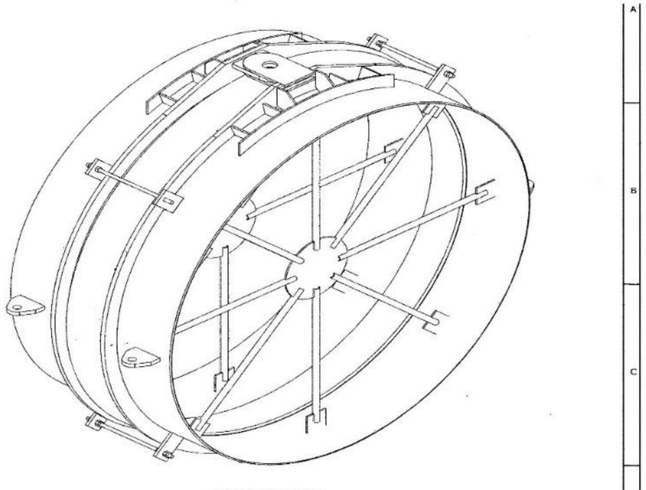
Single Hinged Expansion Joint

Tied Universal Expansion Joint

Dogbone Expansion Joint

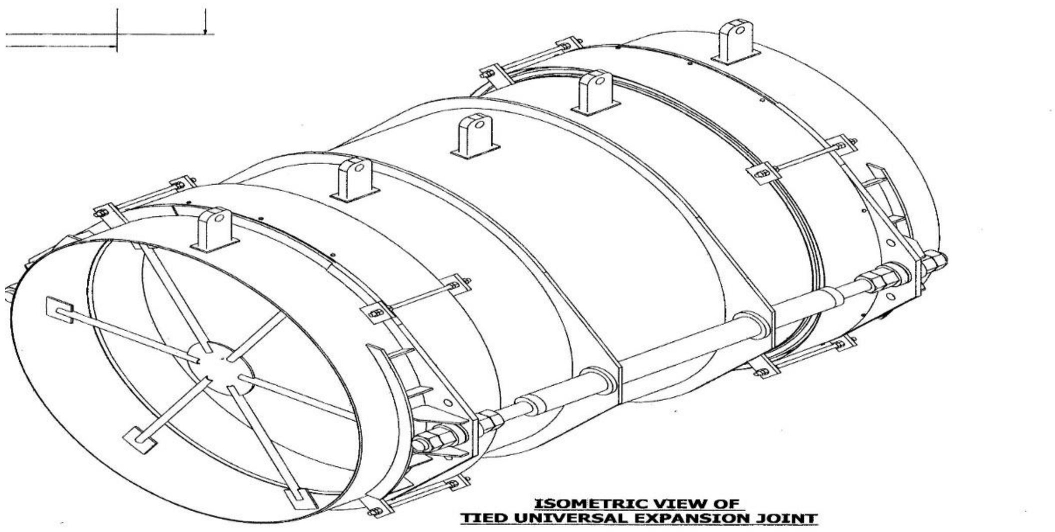
Single Expansion Joint (x2)

Single Hinged Expansion Joint

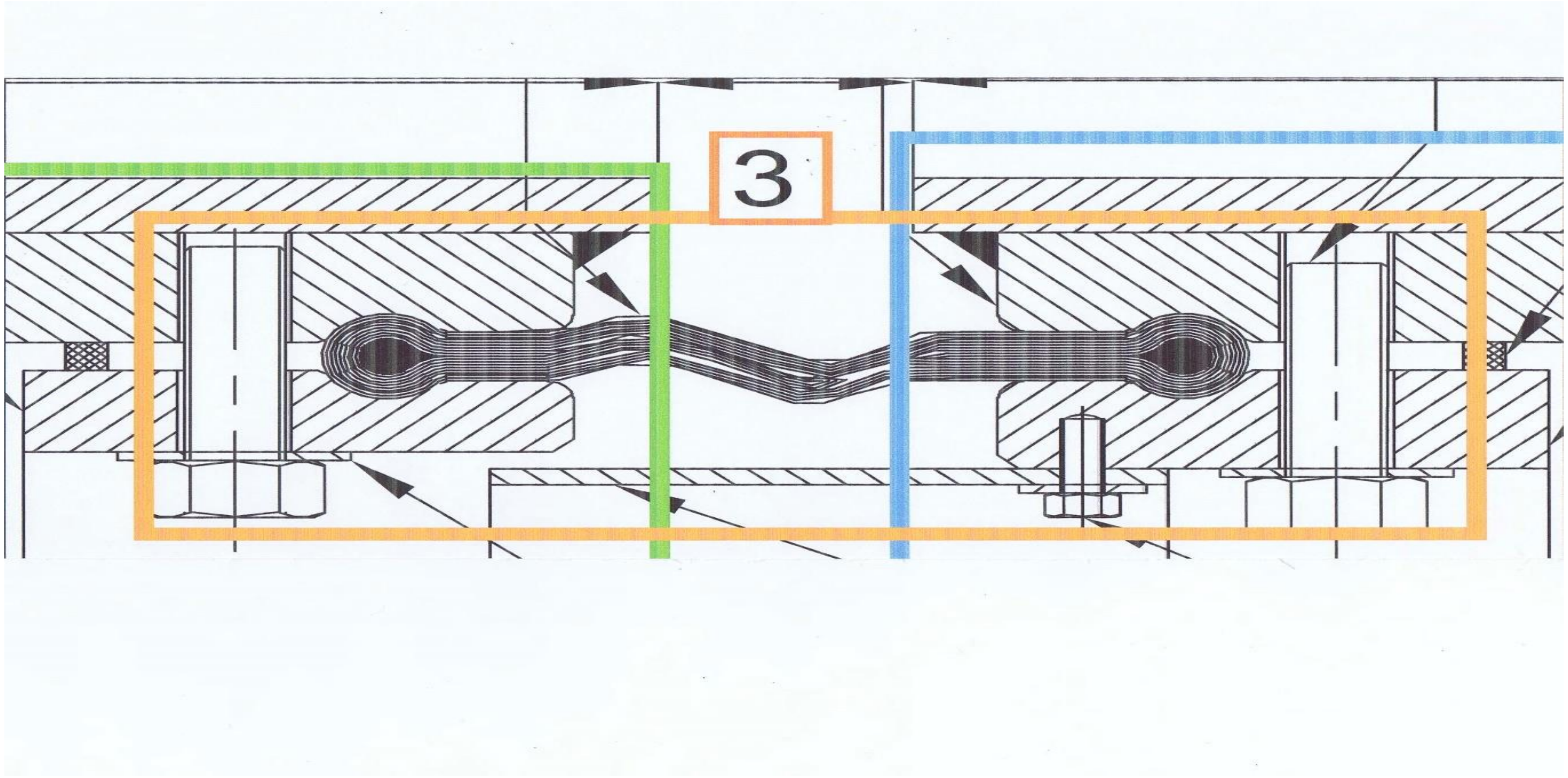


ISOMETRIC VIEW OF
SINGLE HINGED EXPANSION JOINT

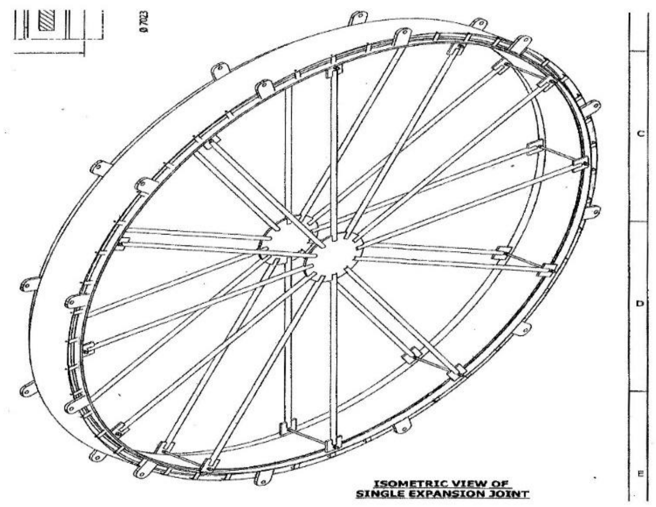
Tied Universal Expansion Joint



Dogbone Expansion Joint



Single Expansion Joint (x2)



FIN TUBE BUNDLE

The tube bundles are single-row, single-pass, heat exchangers composed of tubes of flat cross section with aluminum fins.

The tube bundles are of two types; parallel flow (Condenser) and counter-flow (Dephlegmator).

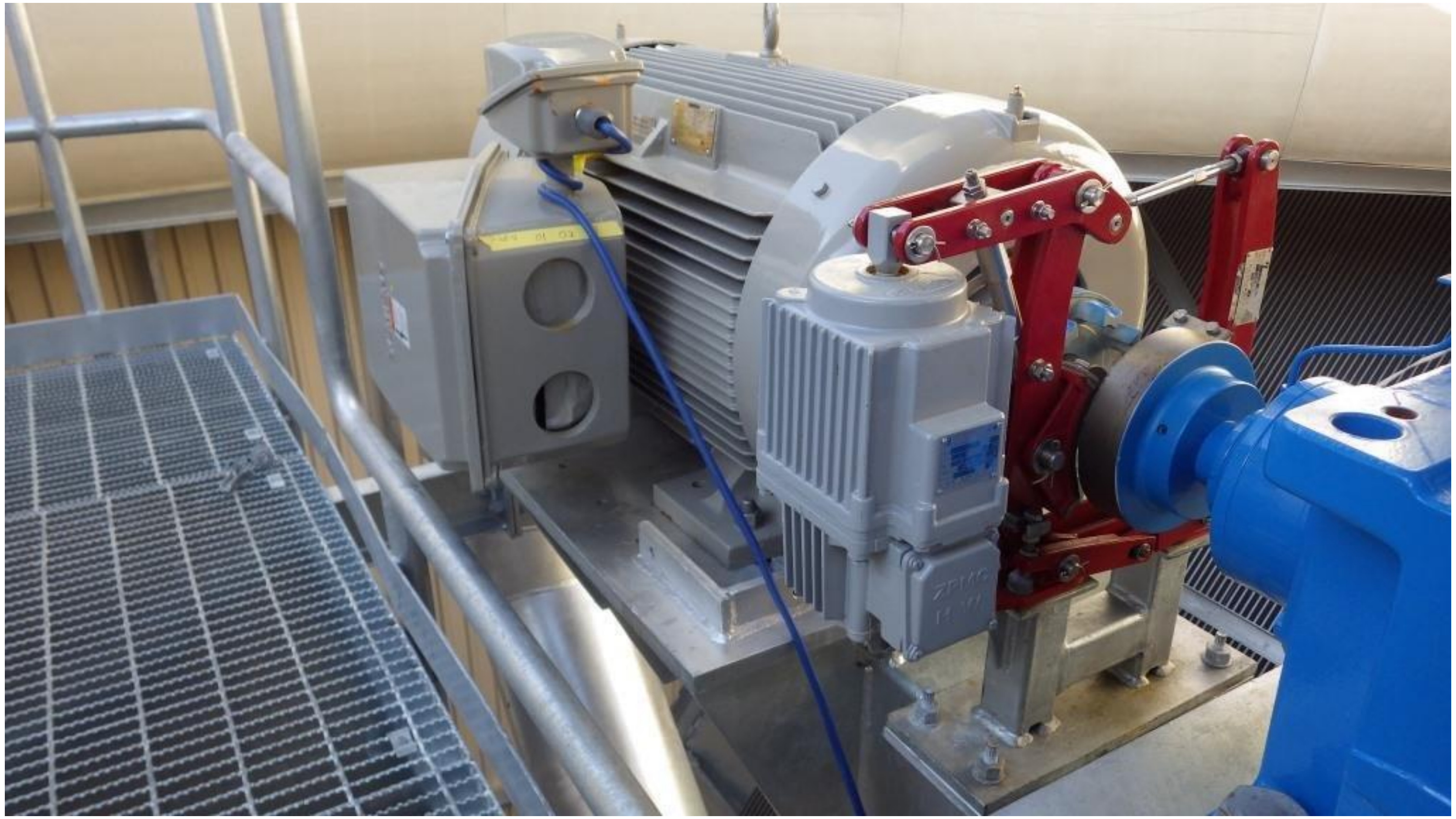
All C bundles are joined together by welding to the steam header.

At their lower ends, all bundles are connected together via integrated condensate collection/steam crossover headers.

Alex Tube Bundle

Single-row, single-pass, heat exchange composed of elliptical cross section with aluminum fins

FAN BRAKE



CPV TOWANTIC Fan

Manufacturer	Cofimco
Quantity	30
Model	10973-7-60F/AX1.5
Diameter Ft.	36
Number of blades	7
Blade pitch	17.3º
Weight lb.	5187

Gearbox

Number	30
Manufacturer	Siemens
Type	Right Angle
Model	B3NV 10
Ratio	32.8/1
Weight without oil, lb	2755
Oil capacity	17.5 gal


2016/06/22 14:15


2017/01/25 14:51

ACC MAINTENANCE

Table 8-1 Maintenance and servicing work

Intervals and time limits	Measures
As required	Replace the wet-air filter Clean the air filter Clean the fan and gear unit
Daily	Check the oil temperature Check the oil pressure (if pressure lubrication is fitted) Check for changes in the gear unit noise Check the water pressure
Monthly and prior to every start-up	Check for leaks Check the oil level
400 operating hours after commissioning	Check the water content of the oil Change the oil (or depending on results of the oil sample test) Check that all of the fastening bolts are tight
Every 3 months	Check the speed monitoring of the auxiliary drive Check the auxiliary drive Clean the oil filter Clean the air filter Clean the venting screw
Every 3000 operating hours	Measure the vibration levels of the rolling-contact bearings
Every 3 000 operating hours, at least every 6 months	Regrease taconite seals Regrease Tacolab seals
At least every 6 months (see specification on plate at lubrication point)	Replenish grease in grease-lubricated rolling-contact bearings
Every 5000 operating hours, at least every 10 months	Replenish grease in the oil retaining pipe
Every 12 months	Check the friction linings of the torque-limiting backstop Inspect the hose lines Inspect the shrink disk Check the water content of the oil

Intervals and time limits	Measures
Every 10000 operating hours, at least every 2 years	Change the oil if using mineral oil of API Group I or II or saturated synthetic esters (or depending on the result of the oil sample test) Check the air-oil cooler (the same time as you change the oil) Check the water-oil cooler (the same time as you change the oil)
Every 2 years	Carry out a general inspection of the gear unit Check the cooling coil Check that all of the fastening bolts are tight Clean the fan and gear unit
Every 20 000 operating hours, at least every 4 years	Change the oil if using semi-synthetic oil of API Group III, PAO or PG oil (or depending on the result of the oil sampling)
6 years after the specified date of manufacture	Change the hoses

Fan Motor

Number	30
Manufacturer	Siemens
Type	SD10MS
Frame	449TS
Speed rpm	1800/900
Electrical data	460V, 3 phase, 60 Hz
Power rating, hp	200/50

AIR REMOVAL SYSTEM

Liquid ring vacuum pumps – Dekker Vacuum Technologies

- Model # DVW2006DF1-50

Deaerator Ejector – Mazda Limited

- Single stage ejector
- Qty. 2

DA EJECTOR

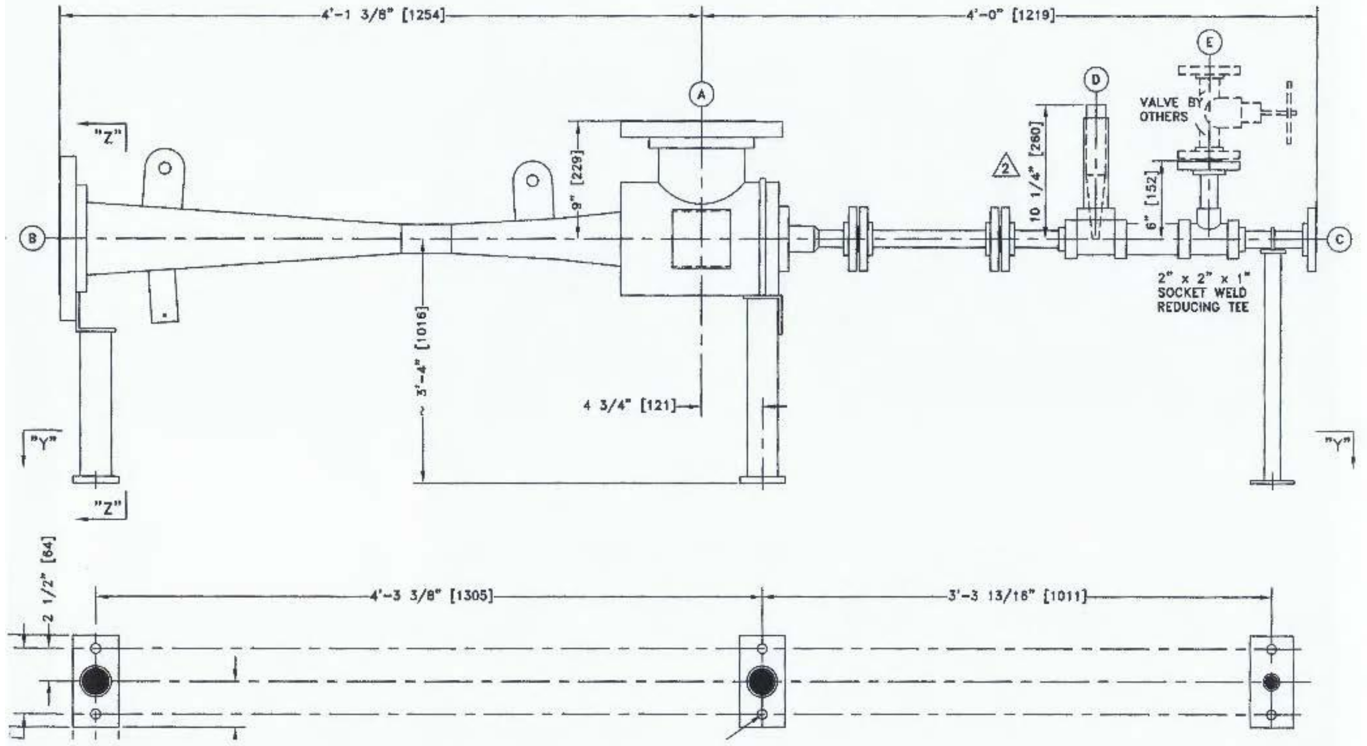
Number: 2

Model: Single Stage Ejector

Manufacturer: Mazda Limited

Motive Steam PSIA: 164

Motive Steam Temp: 360 - 550°F



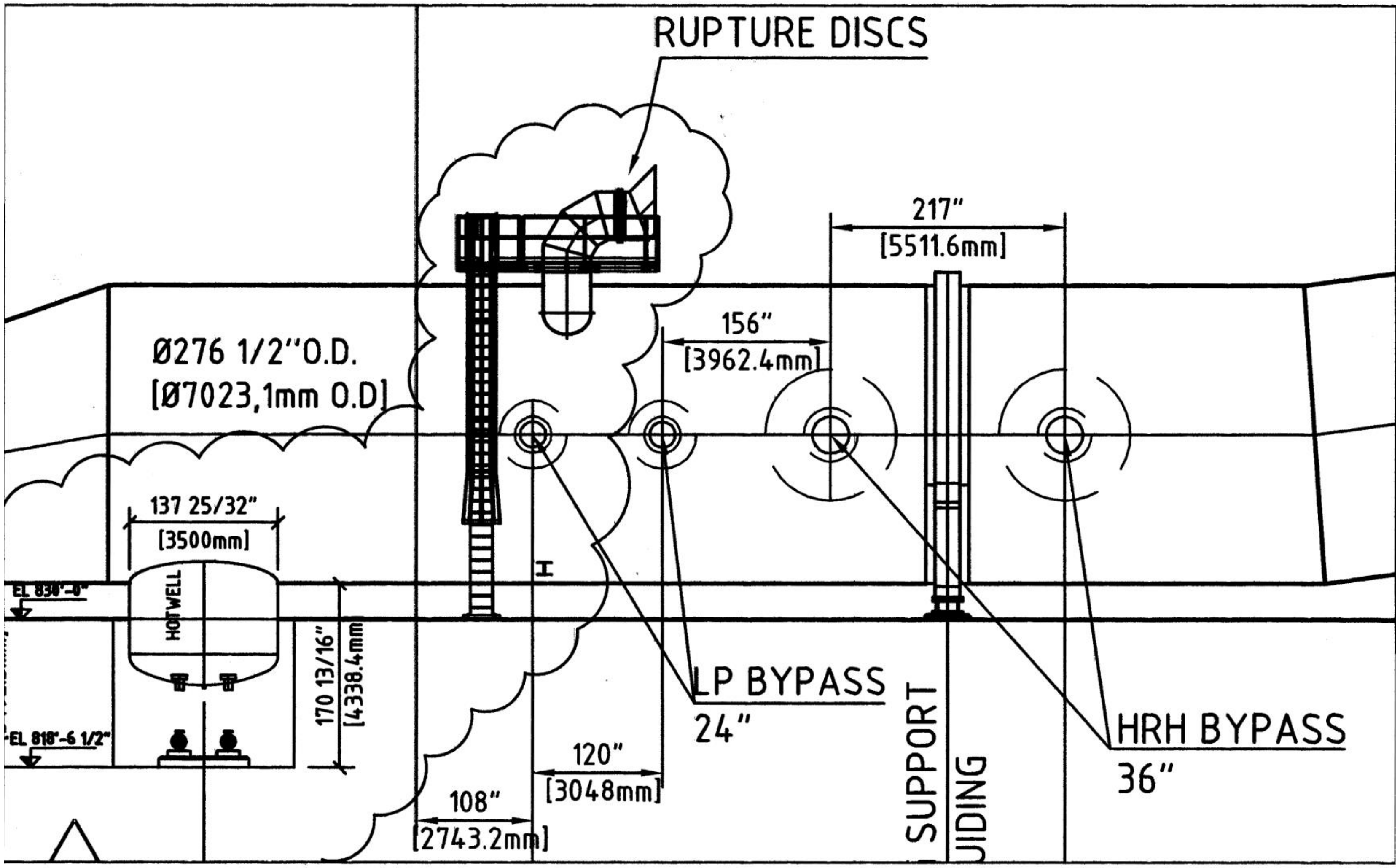
Prevention of Cavitation

LRVP’s are exposed to a certain risk of cavitation which may cause damage to the rotor

An air valve is provided for LRVP cavitation protection

Cavitation may occur:

- If suction pressure is too close to the saturation pressure corresponding to the operating liquid temperature
- Suction pressure too low
- Too high flow of entrained water vapor (steam)
- Suction pressure to high at full load operation in summer
- Too high cooling water temperature in relation to suction pressure


RUPTURE DISCS
217"
[5511.6mm]
156"
[3962.4mm]
Ø276 1/2"O.D.
[Ø7023,1mm O.D]
137 25/32"
[3500mm]
EL 830'-0"
HOTWELL
170 13/16"
[4338.4mm]
EL 818'-6 1/2"
LP BYPASS
24"
SUPPORT
UIDING
HRH BYPASS
36"
120"
[3048mm]
108"
[2743.2mm]

Fin Tube Cleaning System (FTCS) as built

Model: AX P/122/130-B

High Pressure Spray System

Cleaning system operation – automatic vertical up and down.

Manual horizontal movement of ladder support along bundle face.

Cleaning width approx. 4.7 feet

Number of nozzles – 22

Working pressure maximum 1450 psi.

Flow rate: 32 gpm

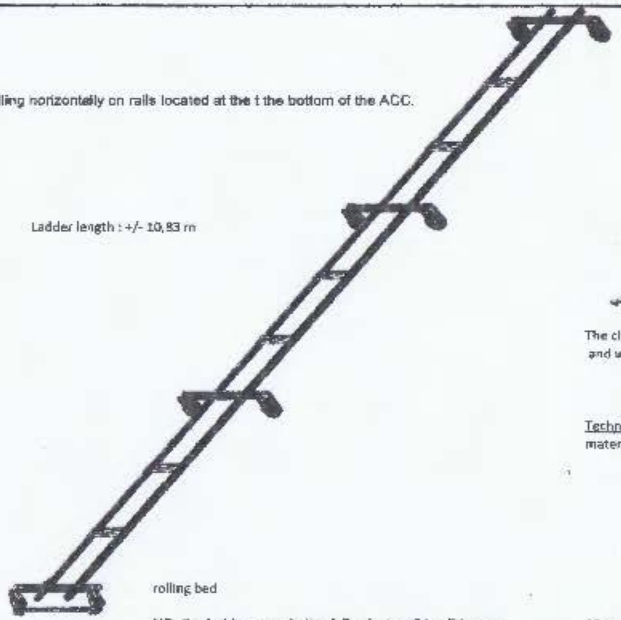
Date: 02.02.2017

AX SYSTEM

NO ACCESS ROLLING LADDER

The ladder is rolling horizontally on rails located at the t the bottom of the ACC.

Ladder length : +/- 10,83 m



The cleaning Head is rolling along the:ladder with standard nozzels carrier and wing nozzels carrier for the ACC edges

<u>Technical data :</u>

material   ladder Aluminium
            Wheel : full rubber tires

rolling bed

NB: the ladders needs the followings rail to slide on: 12 x 2 lengths (3,3m long)   galvanized rail

picture are given only for illustration and are not contractual

75-016rev1	**AX SYSTEM** SARL - Capital 40000 Euros - SIRET 50234959000021 - contact@ax-system.com Allée des Prêles 59270 BAILLEUL France - Tel +33 (0) 961607349 Fax +33 (0)328435840	Towantic project

Fin Tube Cleaning System Access Door

Cleaning History

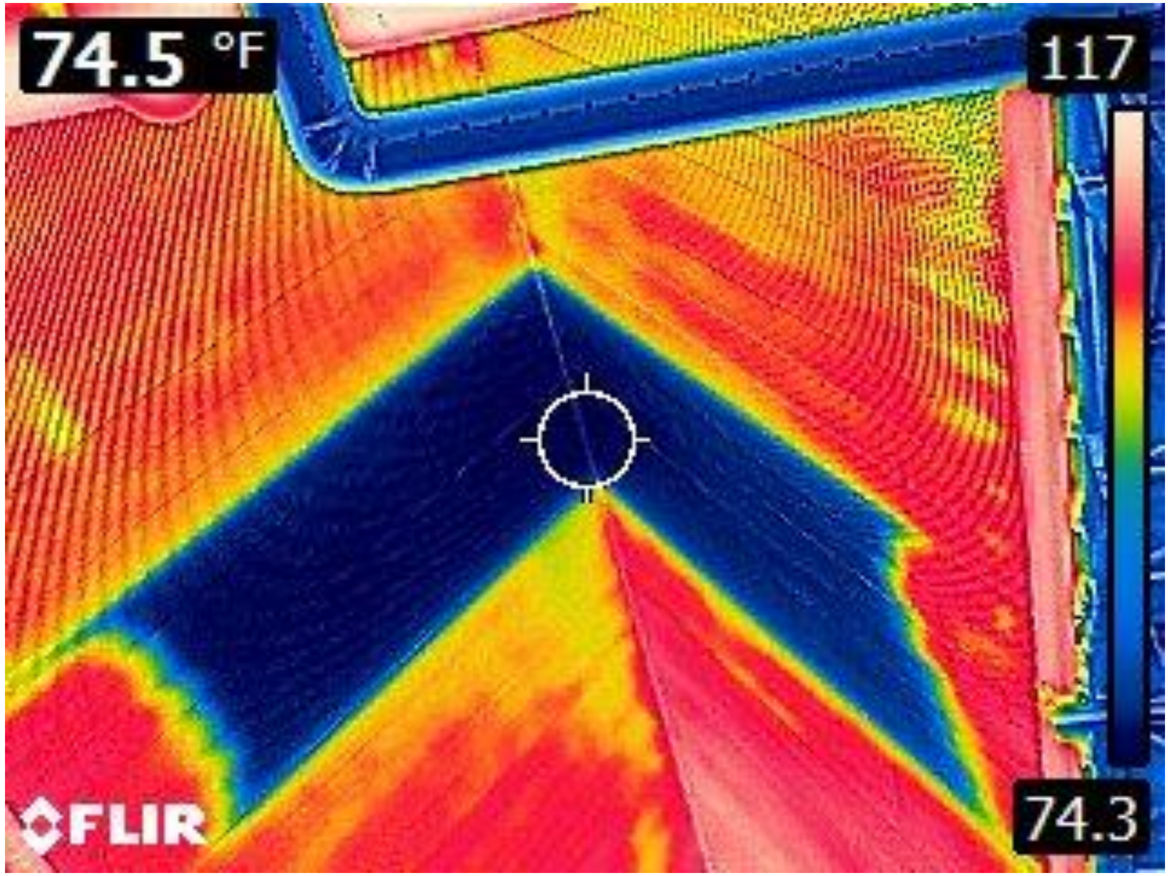
Towantic has completed two full ACC cleanings since commercial operation. Both cleanings, we’ve contracted JSI to complete the work.

Due to an inoperable cleaning system from construction and lack of equipment, JSI fabricated equipment that mounts onto our existing cleaning rig to complete the wash. This included the nozzle head and the pump system.

The other obstacle we’ve encountered is the limit of wash water that is allowed to be used by the state of Connecticut. For both washed, we were only allowed up to 15,000 GPD to ground. This equated to ~6.75 hours of washing per day with JSI’s setup.

CPV Towantic

ISSUES ENCOUNTERED


74.5 °F
117
74.3
FLIR

CPV Towantic

BEST PRACTICES

The plant began on a semi-annual basis to utilize a filter press (water and particulate, 6 micron) to all gearboxes and run for 1-1/2 to 2 hours for each. This combined with oil samples, prior to filter pressing, provides a good indication as to where we are with the oil condition for each gear box. This also keeps the seals on the gearbox from failing prematurely and allows us to see if anything is breaking down in the gearbox.

The plant installed vibration probes to each ACC motor (x3) and gearbox (x3) run cables to a remote location. A total of 190 probes were installed on the ACC assemblies. This allows us to take vibration readings monthly on running ACC equipment, providing good vibration data on a regular basis. This allows the site to understand condition of the equipment prior to failures, and correct, i.e., alignment, coupling failure, motor or gearbox bearing failures.

Results for both implementations: Potential savings of ~$105k

At Valley Energy Center

Knowing the challenges and time associated with disassembly and reassembly of the fan blades and hub assembly to change out a seal, the Maintenance Department recognized the need for a new seal design that would require minimal disassembly. The team worked to understand the failure mechanism and brought in Corrosion Products & Equipment (CPE) to collaborate on a solution. A flange mount split seal was chosen. After a year of operation, the Inpro seal solution has been leak free and reliable.

CPV Towantic

ACC SEQUENCE OF OPERATION

Condenser Control MODES

Auto Control

- Integral control of the exhaust pressure by manipulation of the fan speed sequence
- Switching OFF and ON of a single fan or a group of fans according to the FAN STEP CONFIGURATION CHART
- OPENING and CLOSING SDD valves according to the FAN STEP CONFIGURATION

Manual Control

- MANUAL mode is only foreseen for repair or maintenance
- If a component cannot be set to AUTOMATIC mode at the start-up of the group control a WARNING alarm is generated. The operator must decide if it is possible to start and operate the plant safely.

ACC Operation

Steam turbine exhaust steam is conveyed through turbine exhaust transition into the steam duct to the manifold into the 6 street risers connected to the steam header above the tube bundles of the air-cooled condenser.

The steam header conveys steam to the condensing cells. Condenser tube bundles are installed below the fans.

Condensing cells 1, 3, and 5 are parallel flow condensing tube bundles or “C” bundles.

The 2nd and 4th cell in each row are combination modules which contain parallel flow or “C” and counterflow dephlegmator bundles or “D” bundles.

The “D” bundles are connected to the Condenser Air Extraction System for removal of air and noncondensable gasses.

Condenser vacuum is initially developed by operation of both liquid ring vacuum pumps and maintained by collapsing of steam within the fin tube bundles. The liquid ring vacuum pump (LRVP) remove the air and non-condensables from the ACC during normal operation.

The condensate tank receives and stores the condensate after it passes thru the DA or is pumped from the ACC drain pot.

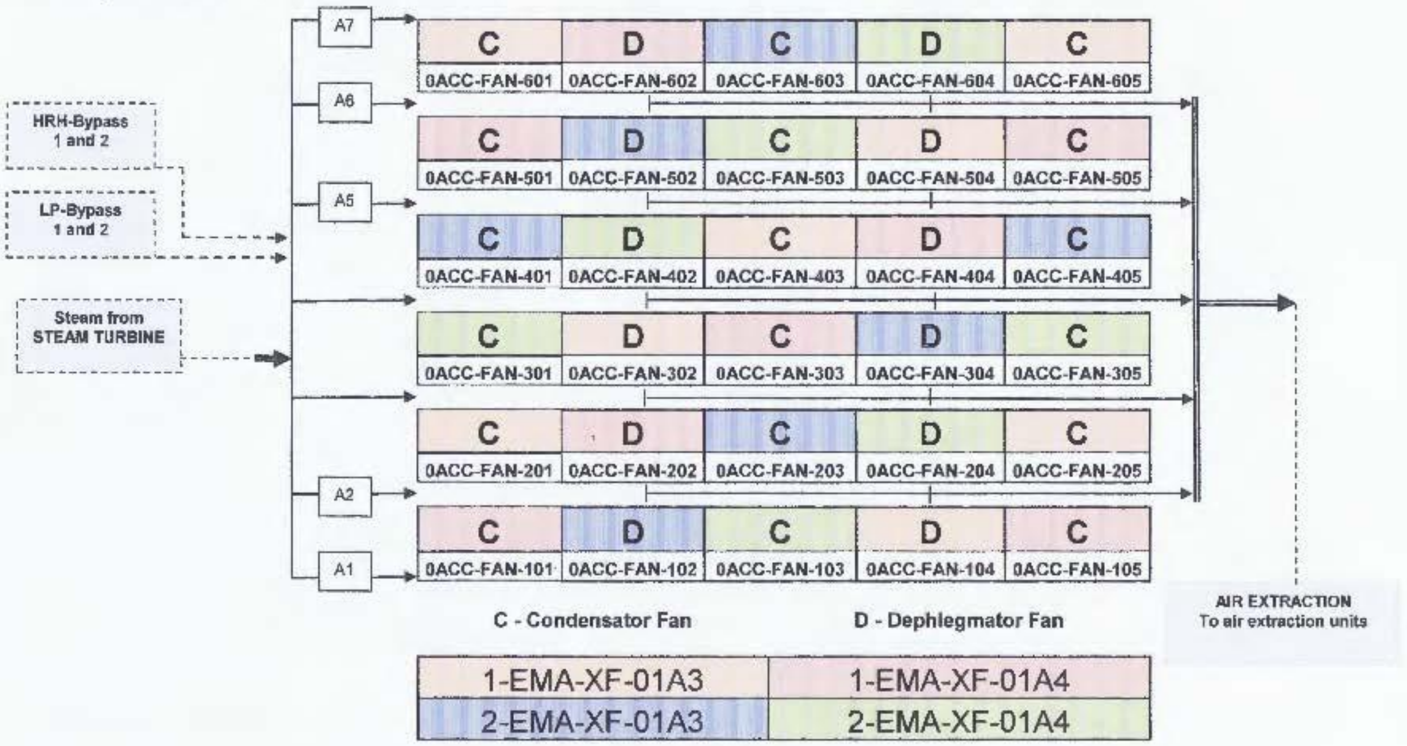
The DA ejector removes the non-condensable gases from the deaerator.

The drain pot is the lowest point in the exhaust duct and collects all condensate from the exhaust duct. Drain pot level is controlled by the drain pot pumps

Balance line connected between the duct and the condensate tank to equalize pressure and provide motive steam for the DA

3.6.6. Fan Step Configuration

Arrangement of Fan Units



Setting Condensate Sub-cooling

Condensate sub-cooling is detected by measuring the condensate temperature at the condensate collecting lines of the ACC which drain to the condensate tank.

Depending on step number one condensate temperature drops to sub-cooled 18°F below saturation temperature for 300 seconds

Warning signal indication (COND SUB-COOLING) on operator screen

LAG/Stand-by LRVP unit is switched ON

Condensate temperature recovers to <11°F after completion of 600 second timer

At completion of 600 second timer COND SUB-COOLING has not recovered continue LAG LRVP operation until condition clears

Alarm signal on operator screen disappears

LAG LRVP is switched off

Normal operation resumes

STAND-BY MODE

Stand-by Mode is provided to allow the ACC to remain under vacuum and the system is ready to receive steam at any time.

While in stand-by mode the main condensate system, steam seals, drain pot system and air extraction system must remain in operation

Stand-by mode is confirmed automatically when:

- All fans are OFF and steam valves CLOSED for 1 hour.
- During stand-by mode the ACC pressure controller is set in-active, i.e. OFF
- During stand-by mode the DA jet is switched OFF
- During stand-by mode the ACC backpressure is <1.45 psia the LRVP is STOP
- ACC backpressure is >2.18 psia the lead LRVP is started

When one of the steam valves (BYPASS or ST) is opened Stand-by mode is finished

LRVP starts

Condensate temperature (3 out of 4) >95^{o}F ACC pressure controller is released to control backpressure

DA ejector started

Shut Down

Reduce condenser air flow in accordance with steam flow

Fan control maintained in Auto Mode

No steam to the ACC Fans are stopped

GC ACC – STOP

- ACC pressure controller – MANUAL/DISABLED
- DA ejector shut down
- LRVP stopped

Open vacuum breaker

ACC pressure >13 psia GC ACC is switched OFF

The level control of the condensate tank and drain pot remains active.

Operation Surveillance and Tests

Temperature; duct and condensate

Condensate quality

Vacuum Test

- Acoustic or thermal testing

Vacuum Decay Test

The Vacuum Decay Test is conducted as follows: With steam flow to the condenser and fan speeds held constant, STOP the holding LRVP and monitor the rate of pressure rise in the condenser period of 10 – 15 minutes. The normal rate of pressure increase is in the range of < 0.00435 psi/min.

Date:	5/8/2019	10/30/2019	1/16/2020	4/8/2020	6/22/2020	10/6/2020	2/5/2021	5/21/2021	7/14/2021	10/29/2021	2/2/2022	5/24/2022	8/16/2022
Time for Pressure Rise	16.00	11.00	10.00	10.00	15.00	15.00	15.00	10.00	10.00	10.00	10.00	16.00	15.00
Pressure Start	1.62	1.87	2.05	1.92	1.726844	1.38	1.4	1.51	1.82	1.46	1.53	1.392572	1.41
Pressure End	2.19	2.49	2.44	2.5	1.73078	1.42	1.5	1.53	1.85	1.53	1.62	1.45122	1.47
Pressure Rise	0.57	0.62	0.39	0.58	0.003936	0.04	0.1	0.02	0.03	0.07	0.09	0.058648	0.06
psi per minute (<.00435/min)	0.03563	0.05636	0.03900	0.05800	0.00026	0.00267	0.00667	0.00200	0.00300	0.00700	0.00900	0.00367	0.00400
SCFM (~7 scfm)		8	20.6	27.5	10	1.8	11	3.4	3.7	5	7.33	10	10
Time to return	Unable	40	10	Unable	5	unable	12	19	10	10	15	Unable	Unable

Alarms and Instrumentation

Condensing System alarms are generated by the DCS based on abnormal process and equipment operating conditions.

These alarms are recorded by the historian and are viewable on the operator workstations.

Automatic Protection

Overload and Short-Circuit Protection--The ACC fan motors trip on motor overload or short circuit.

Fan Protection--The ACC fan motors trip on fan high vibration and low lube oil pressure.

Freeze Protection – activated when ambient temperature falls below 35.6°F.

Sub-Freezing Operation

32^{o}F and below ice can accumulate in the condenser

Ice formation within tubes can result in complete blockage and eventually bursting

During sub-freezing weather, operation personnel shall include the ACC on their normal plant equipment check

D Warming Function

During sub-freezing operation, ice can accumulate in the upper part of the “D”

To remove ice the “D” fan are stopped periodically to warm the tubes.

D warming function becomes active when ambient temperature is $<35.6^{0}$ after a time delay of 2 hours

D warming cycle is carried out at fan step 14 to 28 only

D warming fan cycle duration is 5 minutes

Active warming cycle from street to street is separated by a 30 minute timer

D warming cycle is suspended when “FREEZE ALARM” is active

During the 5 minute “D” warm-up cycle the ACC pressure controller is “tracking” but will not carry out a fan step.

LOW CONDENSATE TEMPERATURE ACTIONS

18°F subcooling for 5 minutes

⇓

Alarm shall be given COND SUB-COOLING

⇓

LAG/stand-by LRVP unit is switched ON

⇓

Condensate subcooling decreases to 11°F or less at the end of 10 minute timer resume normal operation

---

If subcooling does not decrease to <11° at the end of the timer continue stand-by LRVP operation until clear

⇓

Condensate temperature reaches 59°F set “FREEZE ALARM”

QUESTIONS ???