

	Report	Tutuka Power Station
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Title: Tutuka Fire Protection Demand - Worst Case Scenario

Document Identifier: 15GEN ENG-751

Alternative Reference Number.

Area of Applicability: **Eskom Holdings SOC Ltd**

Functional Area: **Engineering**

Revision **1**

Total Pages. **41**

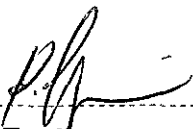
Next Review Date: **N/A**

Disclosure Classification. **Controlled Disclosure**

Compiled by

Functional Responsibility

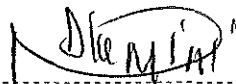
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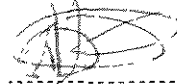
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1. Introduction

Tutuka Power Station was constructed between 1985 and 1991. It consists of six 609MW units

The Eskom Fire Protection & Life Safety Standard [1] and good Fire Systems Engineering practice requires Eskom power stations to record what their fire system worst case fire scenario is and how their pumping and water storage can support the worst case fire scenario as part of their fire system design base

With additional systems such as the turbine pedestal and underfloor protection being added over the years the worst case fire scenario demand has possibly changed. This report defines the different fire systems and the worst case fire scenario. The report then compares the worst case fire scenario to the existing water storage, pumping and piping system

This report aims at identifying all the fire protection systems and evaluates their water demand.

This should be seen as a working document and any modification or addition to the fire protection system must be evaluated against the supply capability of the fire water system and the worst case fire scenario in this report.

2. Supporting Clauses

2.1 Scope

The scope of this report is to identify all the fire protection systems at Tutuka Power Station and their water demand to determine the worst case fire scenario. This scenario/demand will then be compared to the water storage, pumping and piping system and recommendations made based on this outcome.

2.1.1 Purpose

The purpose of this document is to determine the worst case fire scenario, compare it to the available water storage, pumping and piping system and make recommendations based on the outcome

2.1.2 Applicability

This document shall apply to Tutuka Power Station

2.1.3 Effective date

The effective date will be from when the final authorising party signs this document

2.2 Normative/Informative References

Parties using this document shall apply the most recent edition of the documents listed in the following paragraphs.

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2.2.1 Normative

- [1] 07 08/18.00 00 00 C Mather and Platt Tutuka Power Station Operating and Maintenance Manuals for Fire Control and Associated Equipment
- [2] 240-54937450 Fire Protection and Life Safety Design Standard
- [3] 474-11504 Fire Protection System Water Demand WCS Methodology Position Paper
- [4] FMDS07101 Fire protection for steam turbines and electric generators

P&ID Drawings

- [5] 0.61/9264 Schematic diagram of fire control systems and associated services
- [6] 21.61/55225 Common plant raw water supply system
- [7] 21.61/55306 Common plant potable terrace storage & LP distribution system
- [8] 21 61/55309 Common plant air heater washing tank
- [9] 21 61/55404 Fire control pumphouse
- [10] 21.61/55417/18/19/20/21/22s1 Unit 1 Boiler Fire Protection
- [11] 21.61/55417/18/19/20/21/22s2 Unit 1 Boiler Fire Protection
- [12] 21 61/55417/18/19/20/21/22s3 Unit 1 Boiler Fire Protection
- [13] 21.61/55417/18/19/20/21/22s4 Unit 1/2/3/4/5/6 boiler fire protection
- [14] 21.61/55439s1 Fire fighting water distribution
- [15] 21 61/55439s2 Fire fighting water distribution
- [16] 21 61/55439s3 Fire fighting water distribution
- [17] 21.61/55439s4 Fire fighting water distribution
- [18] 21.61/55454s1 MMD workshop and stores sub basement fire protection system
- [19] 21.61/55454s2 MMD workshop and stores ground floor fire protection system
- [20] 21 61/55454s3 MMD workshop and stores first floor fire protection system
- [21] 21.61/55458 Common Plant outside plant control room fire prot
- [22] 21.61/55459 LPS diesel fire protection
- [23] 21.61/55460s1 Lube oil and regen plant fire protection
- [24] 21 61/55460s2 Lube oil and regen plant fire protection
- [25] 21 61/55461 Station transformer protection
- [26] 21.61/55480 Admin building fire protection
- [27] 21.61/55493s1 East fuel oil plant fire protection
- [28] 21 61/55493s2 East fuel oil plant fire protection

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[29]21.61/55500s1	West fuel oil plant fire protection
[30]21 61/55500s2	West fuel oil plant fire protection
[31]21 61/55501	Daily issue oil store fire protection
[32]21.61/55502s1	Coal silos and conveyors fire prot
[33]21.61/55502s2	Coal silos and conveyors fire prot
[34]21.61/55502s3	Coal silos and conveyors fire prot
[35]21 61/55502s4	Coal silos and conveyors fire prot
[36]21 61/55502s5	Coal silos and conveyors fire prot
[37]21.61/55502s6	Coal silos and conveyors fire prot
[38]21.61/55509s1/s2/s3	Coal incline conveyors fire prot
[39]21.61/55585/6/7	Units 1/2/3 & 4/5/6 Diesel Generator fire protection
[40]21.61/55588/9/10/11/12/13s1 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[41]21 61/55588/9/10/11/12/13s2 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[42]21 61/55588/9/10/11/12/13s3 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[43]21 61/55588/9/10/11/12/13s4 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[44]21.61/55588/9/10/11/12/13s5 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[45]21.61/55588/9/10/11/12/13s6 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[46]21 61/55588/9/10/11/12/13s7 system	Unit 1/2/3/4/5/6 turbine house fire protection distribution
[47]21.61/55606/7/8/9/10/11s1	Unit 1/2/3/4/5/6 generator transformer fire prot
[48]21.61/55606/7/8/9/10/11s2	Unit 1/2/3/4/5/6 generator transformer fire prot
[49]21.61/55606/7/8/9/10/11s3	Unit 1/2/3/4/5/6 generator transformer fire prot
[50]21 61/55606/7/8/9/10/11s4	Unit 1/2/3/4/5/6 generator transformer fire prot
[51]21 61/55612/13/14/15/16/17s1	Unit 1/2/3/4/5/6 turbine fire protection
[52]21 61/55612/13/14/15/16/17s2	Unit 1/2/3/4/5/6 turbine fire protection
[53]21.61/55678	Station diesel generator protection

Mechanical Drawings

[54]Turbine underfloor mechanical drawings to be found on Tutuka G drive at.
G \GROUP\ENGAuxilliary Eng\Fire Protection\Fire drawings\Drwngs\Mechanical Drawings\Tutuka.zip\Tutuka\PDF Drawings

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2.2.2 Informative

[55]240-54937439 Fire Protection/Detection Assessment Standard

[56]240-56737448 Fire Detection and Life Safety Design Standard

[57]ASIB 11th Edition Rules

[58]FM Global Property Loss Prevention Data Sheet 7-101 Fire Protection for Steam Turbines and Electric Generators

[59]NFPA 850 Recommended Practice for Fire Protection for Electric Generating Plants

2.3 Definitions

Definition	Description
Fire area	Fire Area is an area that is physically separated from other areas by space, barriers, walls, or other means in order to contain fire within that area.
System	For the purpose of this document, system is defined as fire protection over a particular plant.
Worst case fire scenario	Any fixed fire suppression system/s demands that could reasonably be expected to operate simultaneously during a single fire event

2.4 Abbreviations

Abbreviation	Explanation
AMAO	Assumed Maximum Area of Operation
ASIB	Automatic Sprinkler Inspection Bureau
CoE	Centre of Excellence
demin	Demineralised
ECM	Engineering Change Management
FRF	Fire Resistant Fuel
kPa	Kilo-Pascal
ℓ/min (ℓpm)	Litres per minute
LPS	Low Pressure Services
m/s (mps)	Meters per second
Mm	millimetres
NFPA	National Fire Protection Association
PEIC	Production Engineering Integration Coal
SANS	South African National Standards

2.5 Roles and Responsibilities

Power Station System Engineer.

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- Accountable to gather all detail of fire system on site and draft report in accordance with the documented methodology.

Centre of Excellence (CoE) Engineering.

- Responsible to review and support system engineering in drafting, concluding and recommendations of the report.

2.6 Process for Monitoring

An official review process shall take place between site engineering and CoE engineering to support the details of the report.

2.7 Related/Supporting Documents

Not applicable.

3. Tutuka Fire Protection System

3.1 Baseline documentation

Little of the original baseline documentation has been kept by Tutuka power station. Either it was *never handed over or has been misplaced* over the years. It is for this reason that having a central document centre where all documentation is kept is critical. All new projects must be handed over to the Tutuka document centre where it can be catalogued. All manuals; datasheets (valves, nozzles, sprinklers, etc); pump performance documentation, operating, maintenance and control philosophies must be kept at the document centre.

Apart from P&ID drawings (Appendix B), valve schedules (Appendix C) and the hydraulic analysis (Appendix D) the only document available is the Mather and Platt Tutuka Power Station Operating and Maintenance Manuals for Fire Control and Associated Equipment [1]

3.2 Current water storage, pumping and piping on the station

The Tutuka fire system was designed and installed by Mather and Platt. The pumps, alarm and control valves are mostly Mather and Platt. Mather and Platt moved away from alarm and control valves and now only focus on pumps. For this reason some valves are different brands such as Viking and Floval. The system was designed using the British Standard. For this reason any new flanges or pipework must be specified using this standard.

The system is supplied from a potable head tank (2 000m³) [7] and has a backup feed directly from the raw water supply [6]. The potable and raw pipes supplying the pump house are 600NB. The potable tank is also used for all the potable supply on the station.

The raw water supply comes from two reservoirs at the ash disposal site via a 1 200mm pipeline. Each reservoir is 450 000m³ in volume. The raw water is also used by the water treatment plant for processing into potable and demin water.

The static pressure in the fire system is maintained by the air heater washing tank on 95m level [8] at unit 2. This tank is 25m³. The air heater washing tanks are also used to wash the air heaters.

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Table 3-1 summarises the pumps, capacity and drivers. The pump arrangement with potable and raw water supply is shown in drawing [9]

Table 3-1: Pumps, capacity and drivers

Pump	Specifications	Driver
2x Electric Pumps	Type: Mather and Platt 6/8 GME, 2 stage, split horizontal casing Pump duty: 120m head at 6 900lpm Pump Speed: 1 480rpm	Electric motor 200kW, 380V, 405A, 1480rpm
2x Diesel Pumps	Type: Mather and Platt 8/8 GME, single stage, split horizontal casing Pump duty: 120m head at 6 900lpm Pump Speed: 2 100rpm	Brand: Caterpillar, Model 3406, 6 cylinder, 4 stroke, 2300rpm, Displacement 14 6 litres, serial number: *6TB28598*
2x Jockey Pumps	Pump duty: 105m head at 360lpm	15kW, 380V, 29.5A, 2900rpm, Class F insulation, Form FCKW, delta connection, Frame D160M, Bearing riser (RM) LS. 630900, Bearing riser (OS) 620800
1x Floor washing pump	Type: KSB ETA -X80 -315 Centrifugal Pump duty: 100-120m at 3 000lpm Pump Speed: 1 450 rpm	WEG 90kW, 380V, 65A, 2 960rpm

Pressure loss occurs in the system due to leaks and usage. The function of the jockey pumps is to maintain the pressure and prevent the main pumps from starting.

The start sequence of the pumps is as follows:

- Jockey 1: auto start at 900kPa, auto stop at 1 600kPa,
- Jockey 2: auto start at 850kPa; auto stop at 1 600kPa,
- Electric 1: auto start at 800kPa,
- Electric 2: auto start at 750kPa,
- Diesel 1: auto start at 700kPa,

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- Diesel 2 auto start at 650kPa.

Due to using the fire system for excessive floor washing it was found the jockey pumps could not maintain the pressure and the main pumps would start. For this reason a floor washing pump was installed to preserve the main pumps. The pump is manually started in the morning and manually stopped in the afternoon.

The pumps feed into three ring mains namely outside, turbine and boiler [15]. These mains are 350NB. The individual fire protection systems are tapped off from the ring mains. The outside ring main runs above ground around the outside of the boiler and turbine house. On the western side the main is 350NB, to the north and east it is 200NB, and to the south it is 300NB. The turbine ring main is inside the turbine house to the north just below the 16m level and is 400NB. The boiler main runs in the cable tunnels and is 350NB. The outside ring main interconnects with the turbine main between unit 3 and 4 and is 200NB. The turbine main connects with the boiler main between units 1 and 2, 2 and 3, 3 and 4, 4 and 5, 5 and 6 and is 300NB. The boiler main connects with the outside main from the air heaters to the cross conveyors of each unit and is 200NB. All pipework is steel. Drawings [14] to [17] show the outside ring main and individual fire systems.

Drawing [13] gives a complete overview of the fire system. Individual fire systems that are missing from the drawing are:

- Turbine pedestal protection,
- Turbine underfloor protection,
- Secondary CW pump protection,
- Brine concentration plant.

3.3 Fire Protection Systems

Drawing [13] gives a complete overview of the fire system. Individual fire systems that are missing from the drawing are:

- Turbine pedestal protection,
- Turbine underfloor protection,
- Secondary CW pump protection,
- Brine concentration plant.

The individual fire protection systems are broken down in Appendix A. The table breaks the systems down into individual plant areas with control valves, type of protection system, activation method, sprinkler/nozzle data and amount of sprinklers/nozzles

3.4 Worst Case Fire Scenario

While the worst case scenario methodology [3] states that all fire protection systems should be evaluated to determine which is the worst case scenario, for this report only the two scenarios will be calculated. These scenarios come from [3] and are based on knowledge gained from various power stations. The two scenarios are:

1. Generator transformer including Unit transformer A and B.
2. Turbine underfloor protection including secondary CW pumps.

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3.4.1 Generator transformer

The generator transformer, unit transformer A and B are not separated by walls. Neither are the transformers reasonably distanced from each other. Figure 3-1 and Figure 3-2 show the proximity of the transformers relative to each other. This makes the activation of multiple systems highly possible should one transformer combust. The control valves configuration is shown in drawing [47]. The generator fire protection is shown in drawing [49], transformer A fire protection in drawing [48] and transformer B in drawing [50].

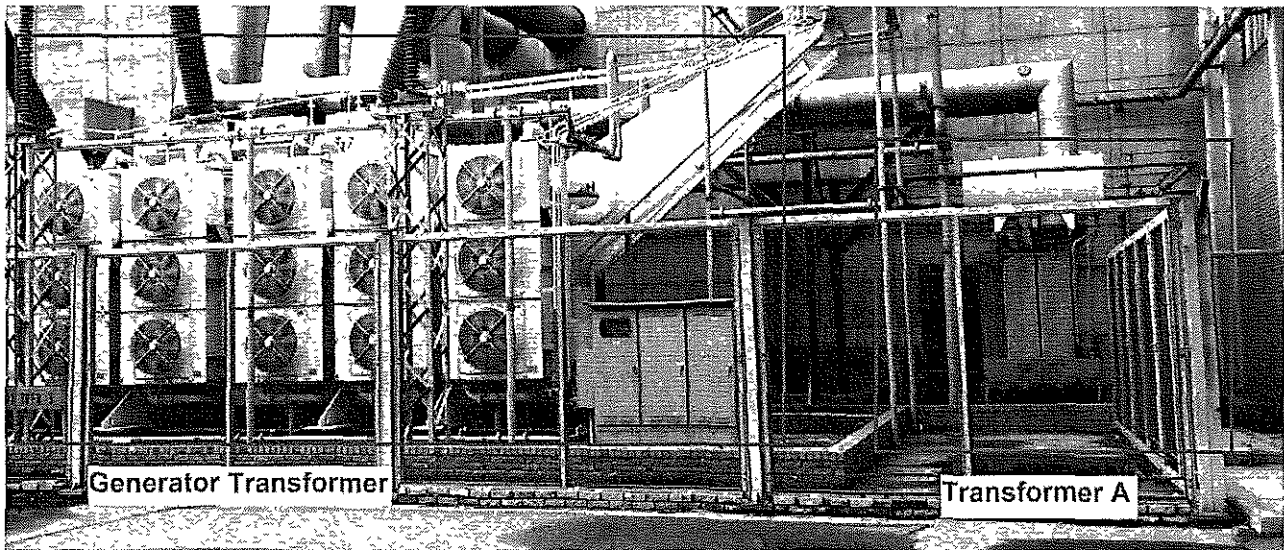


Figure 3-1: Transformer A relative to the Generator transformer

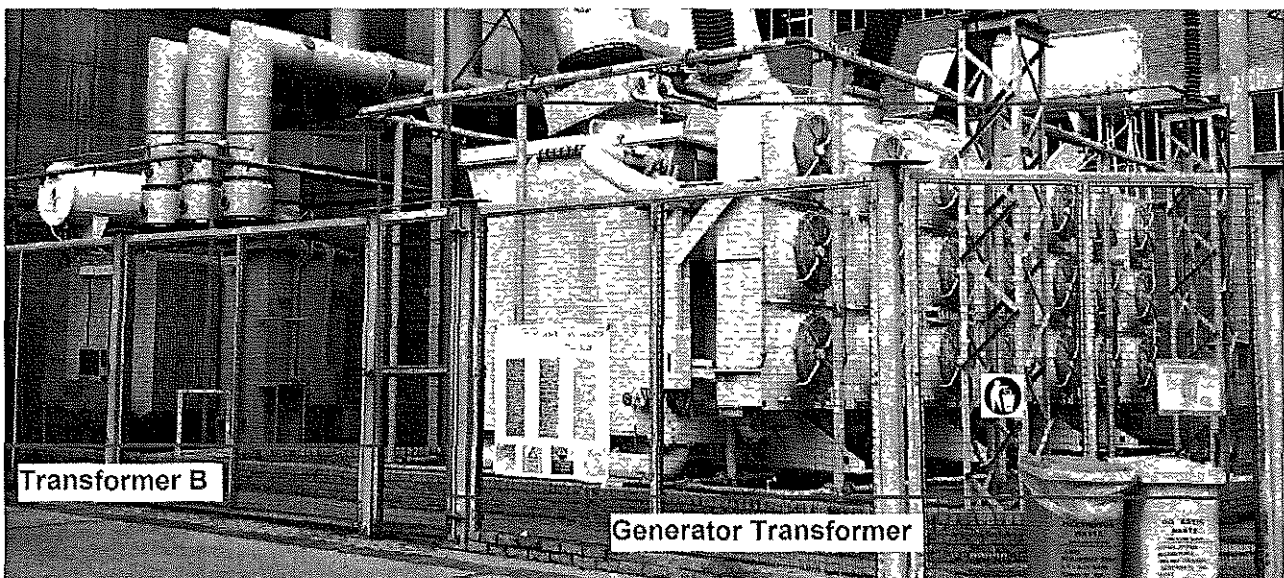


Figure 3-2: Transformer B relative to the Generator transformer

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The control valves are situated inside the turbine on 0m level against the wall (Figure 3-3 Generator transformer complex fire protection control valves)

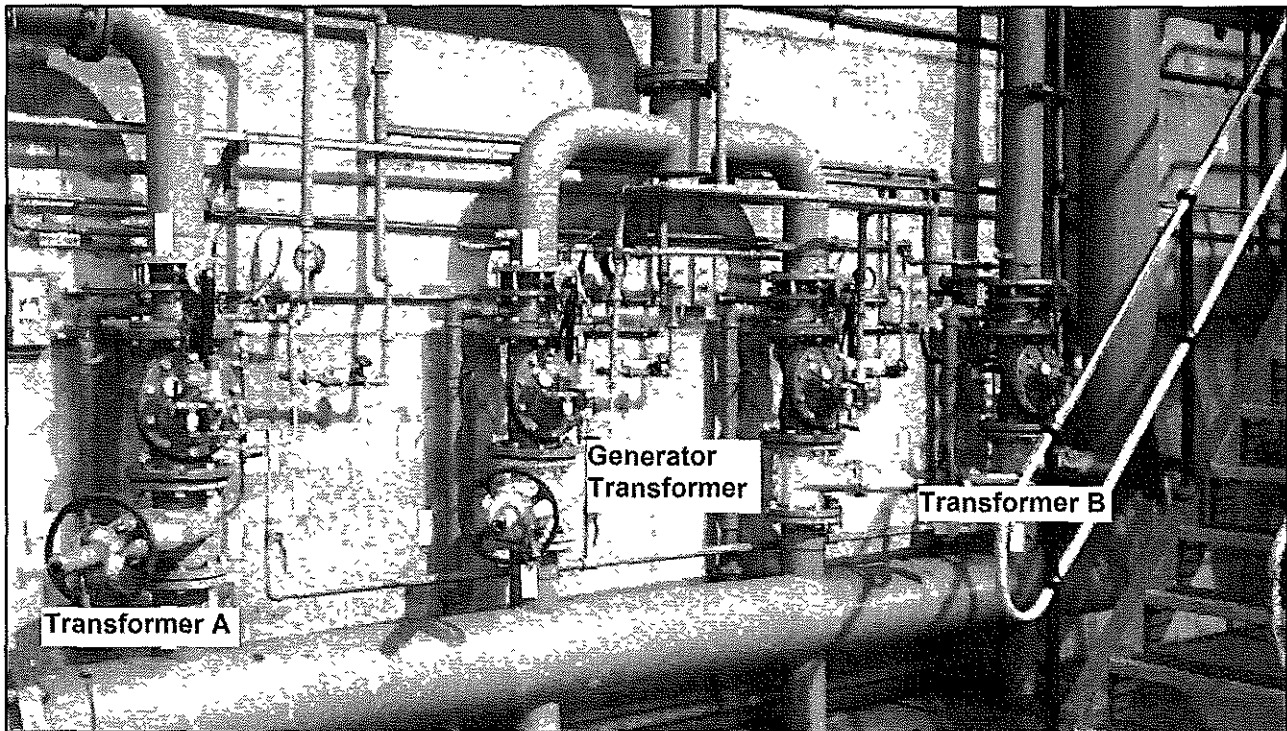


Figure 3-3: Generator transformer complex fire protection control valves

The generator transformer protection is controlled by two pneumatically activated deluge valves (AKZ: UY92 and UY93). These valves discharge into a 200NB common line. These valves supply 10 HV17 nozzles ($k=25.9\ell\text{pm}/\text{bar}^{0.5}$) in the bund and 42 HV26 nozzles ($k=40.3\ell\text{pm}/\text{bar}^{0.5}$). The detection bulbs are set at 68°C.

Transformer A is controlled by a pneumatically activated deluge valve (AKZ: UY94) which feeds into a 150NB line. This valve supplies 14 HV90 nozzles ($k=92.2\ell\text{pm}/\text{bar}^{0.5}$). The detection bulbs are set at 68°C.

Transformer B is controlled by a pneumatically activated deluge valve (AKZ: UY91) which feeds into a 150NB line. This valve supplies 13 HV90 nozzles ($k=92.2\ell\text{pm}/\text{bar}^{0.5}$). The detection bulbs are set at 68°C. The flow calculations are detailed in Appendix E.

Table 3-2: Generator transformer fire area – Flow and pressure requirement at ICV

System	Flow (ℓpm)	Pressure (kPa)	Flow Correction	
			Q (ℓpm)	P (kPa)
Generator Transformer	5066.85	495.47	5705.80	628.31
Transformer A	1734.20	628.31	1734.20	628.31

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Transformer B	1734.20	605 48	1766.59	628.31
TOTAL	8535.25	628 31		
Worst case requirement (with flow correction)			9206.59	628.31

The flow and pressure requirement at ICV is 9 206 59ℓpm at a pressure of 628.31kPa

Figure 3-4 show results of Flownex simulation to generator transformer fire area assuming that the shortest route is not available. Boundary conditions were set at the system inlet node-258 and 264 and outlet node-44. A pressure of 628.31kPa was set to generator transformer ICV at node-44. The system inlet boundary conditions at pump house, node-258 and 264 were set for a total flow of 9 206.59ℓ/min (76.72kg/s on each node) and temperature of 20°C. For the above boundary conditions and a static height of 0m, the pressure required at pump discharge (node-264) to guarantee the required flow to generator transformer fire area is 685 14kPa.

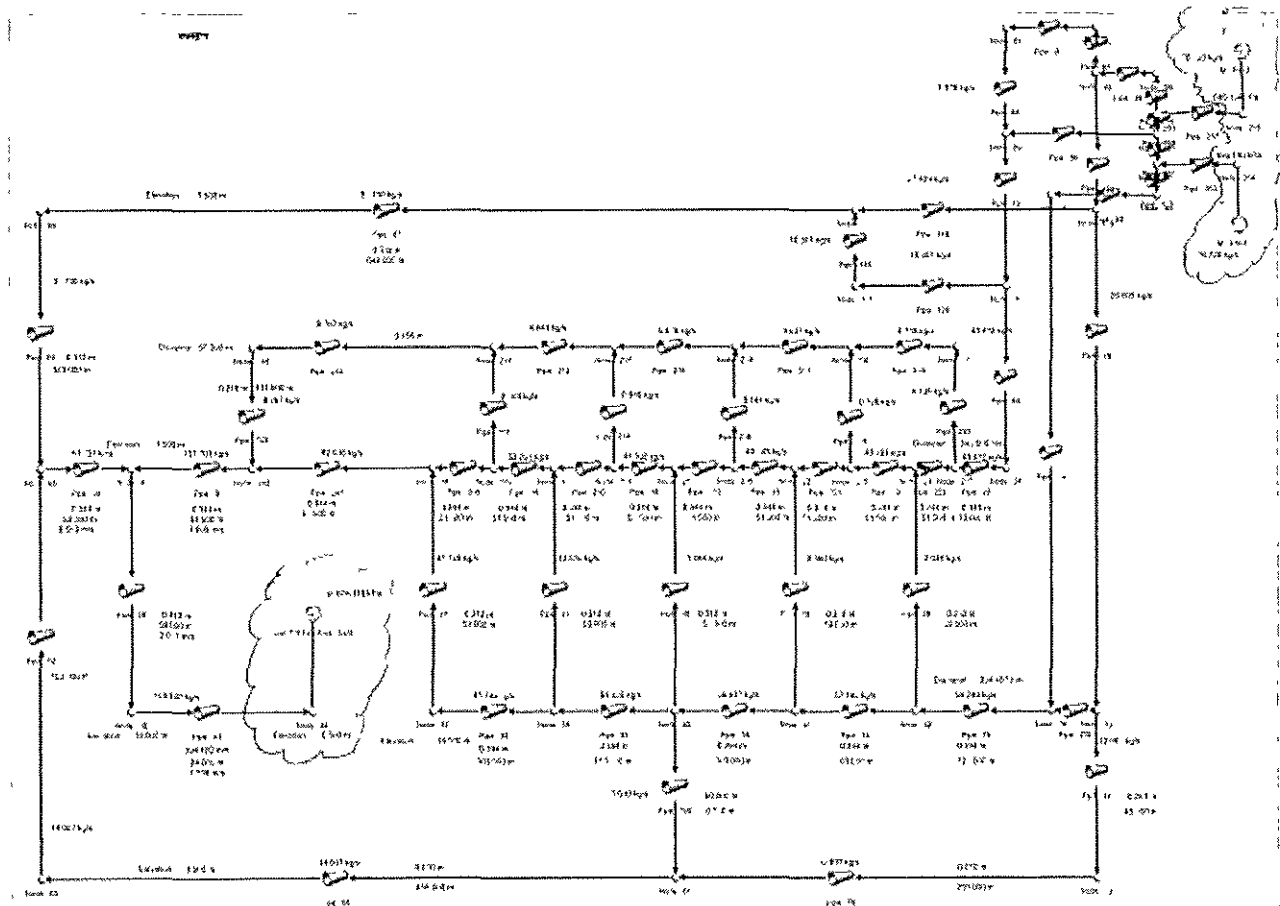


Figure 3-4: Generator transformer fire area – Flownex results

The overall water supply requirements for the generator transformer fire area flow are

1. The total flow required for the under turbine fire area is 9 206.59ℓ/min

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2. The minimum pressure required at pump discharge is 685 14kPa (Node-258 and 264)
3. The minimum water storage required to supply the under turbine fire area is 1 104.80m³
4. The maximum allowable water velocity in the ring main pipe should not exceed 3m/s

3.4.2 Turbine underfloor protection and secondary CW pump system

The turbine underfloor protection consists of the following systems:

- Concrete slopes at 13.9m level,
- Fire protection below HP/IP turbine at 11.8m level,
- Below condenser at 6m level,
- Column protection,
- Below 0m level inside pipe trench,

Since no isometrics of the as built system were available the plant was walked and isometrics with distances and sprinkler locations were sketched (see 37Appendix F). These sketches were used in conjunction with the plan drawings of the protection system for the flow and pressure calculations.

Using the plan drawings, an assumed maximum fire area under the turbine was set. Sprinklers directly under this area would then be activated in a fire event. The total area for all the levels was calculated as 533.27m²

Using the Eskom Worst Case Fire Scenario Methodology Position Paper [3] the flows and pressures were calculated. For each sub system mentioned above the furthest sprinkler was assumed to have a minimum pressure of 50kPa. Using the nozzle formula from [3] the flow through the sprinkler was calculated:

$$Q = k\sqrt{P}$$

Where,

Q= flow in litres per minute,

P= pressure in kPa,

k= discharge constant lpm/kPa^{0.5}

The pipe loss was then calculated to the next sprinkler using the Hazen-Williams formula.

$$P = 6.05 \times 10^7 \left\{ \frac{Q^{1.85} \times L}{C^{1.85} \times D^{4.87}} \right\}$$

Where,

P= the pressure loss in the pipe in kPa,

L= the length of the pipe in m,

Q= flow in lpm,

C= constant for the pipe,

D= the actual pipe inside diameter (ID) or mean diameter in mm

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This process was iterated up to a junction point of a different sprinkler branch. At this junction point a flow correction was then done using

$$Q_1 = \sqrt{\frac{HP}{LP}} \times LPQ$$

Where,

Q_1 = the low pressure flow correct to that of the high pressure flow,

HP= the high pressure at the split of junction,

LP= the low pressure at the split or junction,

LPQ= the flow associated with the low pressure.

The adjusted flow is added to the high pressure flow

Once this had been done for all sub systems the flow and pressure at the control valve was finally determined

The flow and pressure for the secondary CW pump pit was also calculated as well as the flow and pressure for two fire hydrants as per requirements from the Eskom Fire Protection and Life Safety Design Standard [2]

These three flows and pressures were then corrected and summarised in

Table 3-3: Pressure and flow requirement at control valve

Flow and pressure at Junction control valve	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe Ag-ICV Under Turbine	14 599.73	831.27	14 599.73
Pipe ICV PumpPit	401.20	399.91	578.43
Hydrants x 2	2 400.00	350.00	3 698.69
Total	15 000.93	831.27	-
Junction Split	-	831.27	18 876.85

The flow and pressure requirement at ICV is 18 876.85ℓpm at a pressure of 831.27kPa.

Error! Reference source not found. show results of Flownex simulation to under turbine fire area. Boundary conditions were set at the system inlet node-258 and 264 and outlet node-44. A pressure of 831.27kPa was set to under turbine ICV at node-44. The system inlet boundary conditions at pump house, node-258 and 264 were set for a total flow of 18 876.85ℓ/min (157.31kg/s on each node) and temperature of 20°C. For the above boundary conditions and a static height of 0m, the pressure required at pump discharge (node-264) to guarantee the required flow to under turbine fire area is 991.66kPa.

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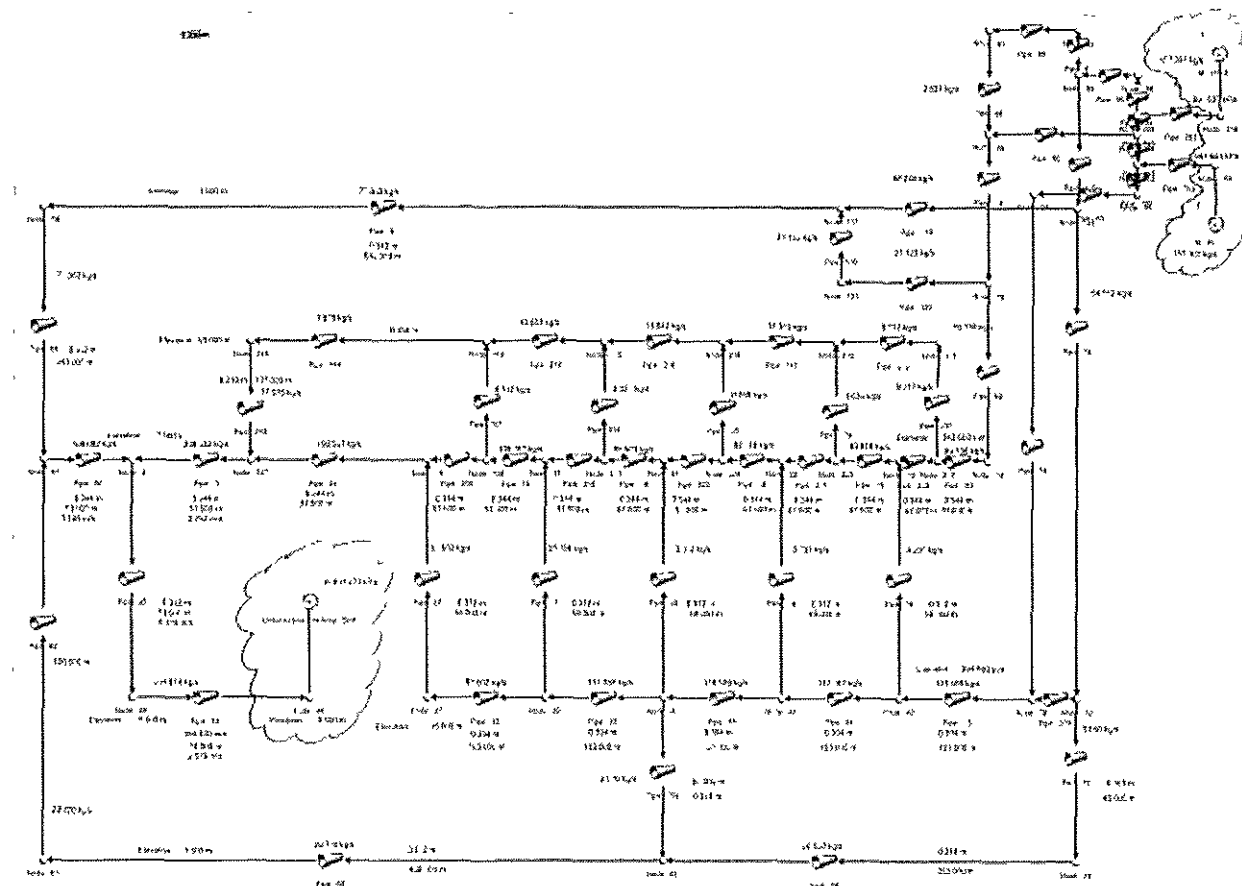


Figure 3-5: Under turbine fire area – Flownex results

The overall water supply requirements for the under turbine flow are:

- 1 The total flow required for the under turbine fire area is 18 876 85l/min.
- 2 The minimum pressure required at pump discharge is 991 66kPa (Node-258 and 264).
- 3 The minimum water storage required to supply the under turbine fire area is 2 265 22m³.
- 4 The maximum allowable water velocity in the ring main pipe should not exceed 3m/s

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The ring main velocity was calculated using:

$$V = \frac{21.22 \times Q}{D^2}$$

$$V = 2,5m/s < 3 \text{ Thus OK!}$$

Where,

V= velocity in pipe in m/s,

Q= flow through the pipe in lpm,

D= actual diameter (mean diameter) of pipe in mm

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The system demand curve was then plotted for various flows

Using the latest pump performance data for the electric and diesel pumps together with the formula to extrapolate a water supply curve from [3], the water supply curves were plotted

The intercepts of the system demand and supply curves were then calculated using the flow against a supply curve formula.

$$Q_J = \left[\frac{P_S - P_E}{\left(\frac{P_S - P_R}{Q_F^{1.85}} \right) - \left(\frac{P_D - P_E}{Q_F^{1.85}} \right)} \right]^{0.54}$$

Where,

Q_J = flow at the junction point,

Q_F = flow in the flow test (water supply)

Q_D = flow at the design point (sprinkler)

P_R = pressure at flow in the flow test (water supply)

P_S = standing pressure in the flow test

P_D = pressure at design point (sprinkler)

P_E = height of the highest sprinkler (kPa)

All flows in litres per minute, all pressures in kilopascal.

3.4.3 Worst case scenarios versus existing water storage, pumping and piping

The actual pump performance test data was plotted for both the electric (Figure 3-6) and diesel (Figure 3-7) pumps. The resistance curve for only the underfloor turbine was plotted as this had the highest pressure and flow demand.

Both the diesel and electric pumps are underperforming. The electric pumps experience significant loss in pressure as the flow increases. This must be investigated further. Most likely the pumps must be refurbished and tested again.

The diesel pumps have a very low churn pressure. This needs to be investigated further. Possibly the pumps have the incorrect impeller size. The pumps must be opened up and the impeller size measured. The pumps must also be refurbished to improve performance.

The worst case scenario demands 2 265.12m³ of water over a 2 hour period. The potable supply of 2 000m³ is therefore slightly inadequate to supply this scenario.

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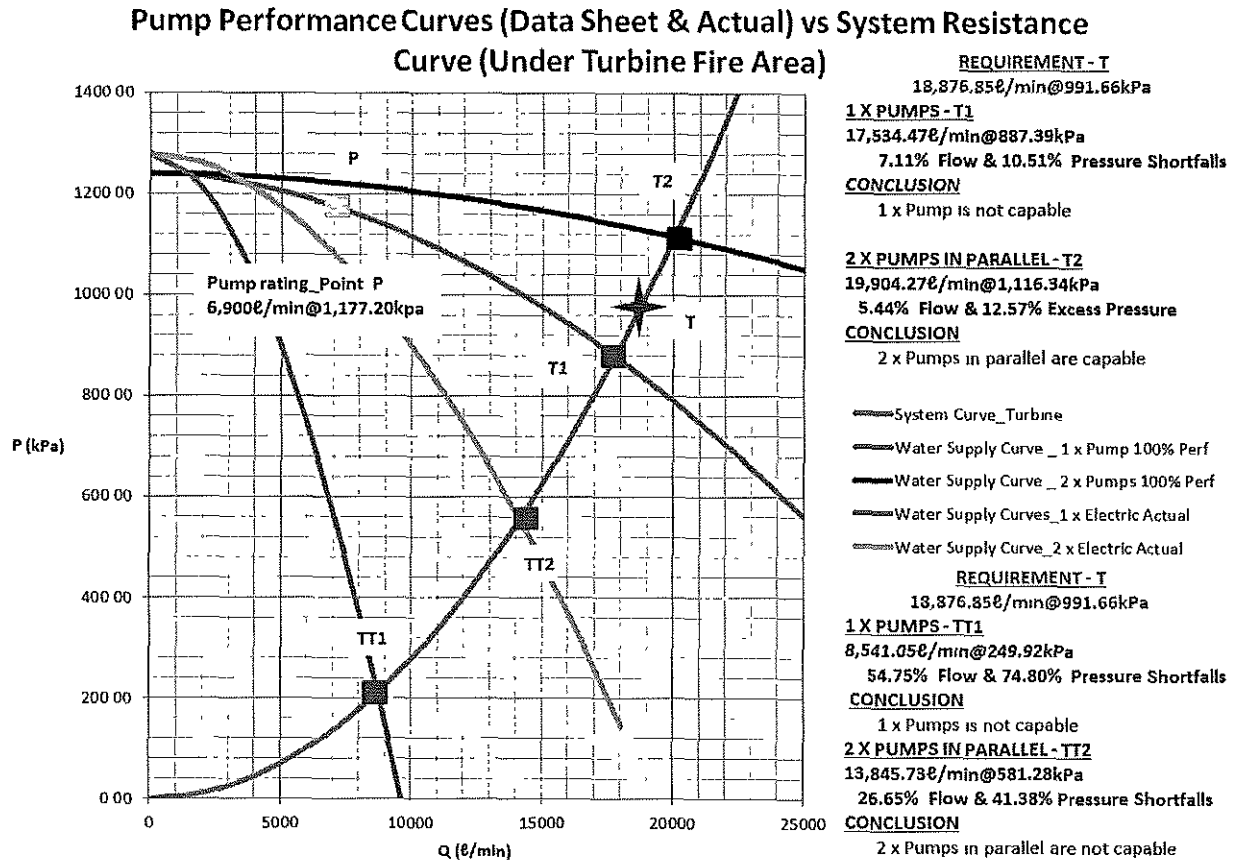


Figure 3-6: Electric pumps supply versus resistance curves

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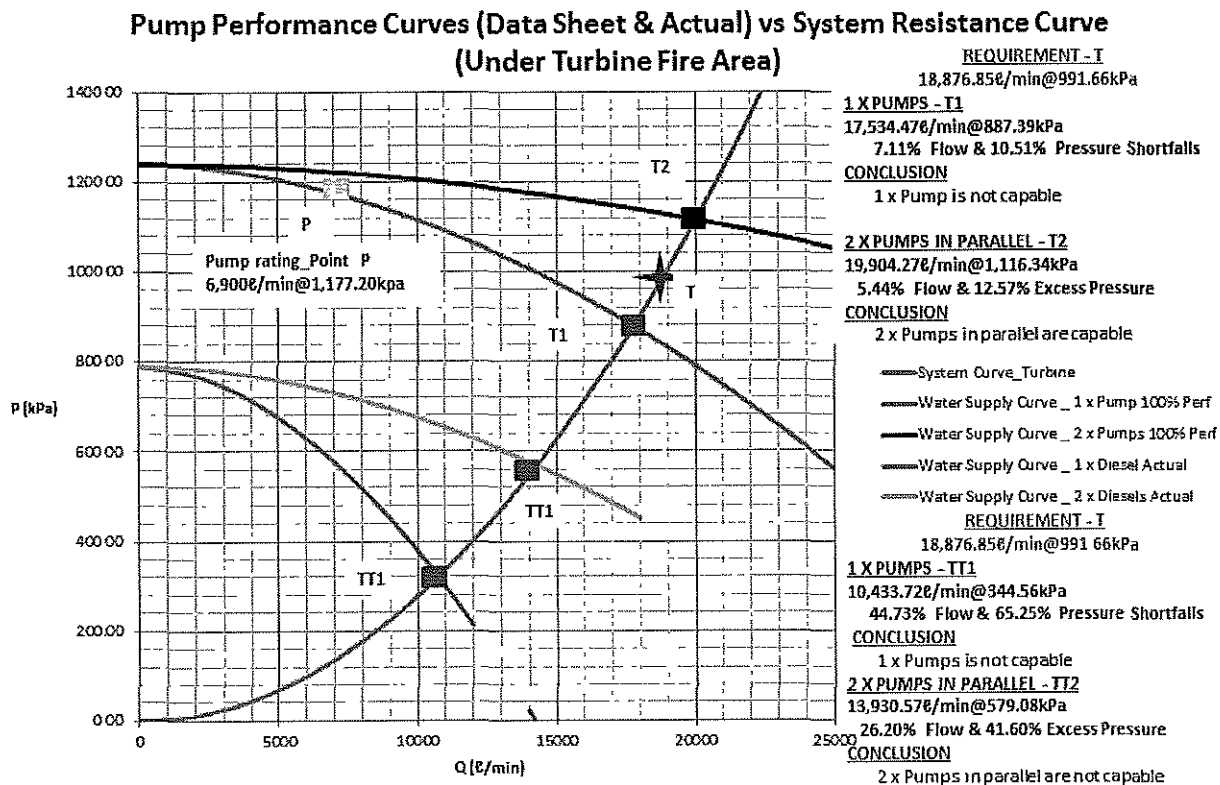


Figure 3-7: Diesel pumps supply versus resistance curves

The summary of the intercepts is in Table 3-4

Table 3-4: Summary of demand and supply curves intercepts

	Flow (lpm)	Pressure (kPa)
Demand	18 876.85	991.66
1 x Pump 100% performance	17 534.47	887.39
2 x Pump 100% performance	19 904.27	1 116.34
1 x Electric Actual	8 541.05	249.92
2 x Electric Actual	13 845.73	581.28
1 x Diesel Actual	10 433.72	344.56
2 x Diesel Actual	13 930.57	579.08

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3.5 Conclusion

The following conclusions can be made based on the evaluation above:

1. The worst case fire scenario is the under turbine fire.
2. The worst case fire scenario has a water flow demand of 18 876.85ℓ/min.
3. The pressure required to guarantee the flow demand at the pump discharge to supply the most hydraulically challenged under turbine for Unit 6 is 991.66kPa when the shortest pipe route is not available.
4. Two duty diesel driven fire pumps running in parallel are capable of supplying a maximum water flow of 13 930.57ℓ/min at a discharge pressure of 579 08kPa.
5. Two duty electrical driven fire pumps running in parallel are capable of supplying a maximum water flow of 13 845.73ℓ/min at a discharge pressure of 581 28kPa.
6. The existing fire pumps are not capable to support the worst case fire scenario requirements (under turbine fire area).
7. The existing usable water storage capacity of 2 000m³ (1hr and 54min) is not capable to support the worst case fire scenario water storage of 2 265.22m³ (2hrs).
8. The existing ring main is capable to support the worst case fire scenario water demand as the water velocity in the pipe of 2.5m/s is less than the recommended maximum of 3m/s

3.6 Recommendations

The following recommendations are proposed in order to ensure adequacy of water supply for the worst case fire scenario:

1. Replace the existing fire pumps with pumps rated at 6 900ℓ/min.
2. During the fire pump replacement project also modify the dedicated test line to facilitate and enhance annual fire pump tests. The test line to discharge in an acceptable receiver such as raw water tank, clarifiers or cooling tower ponds as permitted by site layout

The above combination will reduce the friction losses along the length of the pipe and hence lower the pressure demand

- The new operating point with two pumps running in parallel will be is now point T6_F (19 904.27ℓ/min@1 116 34kPa), which is above the requirements
- Based on the proposed pump replacement, two duty pumps will therefore be capable to provide 100% pumping capacity when running in parallel while leaving the other two pumps to provide 100% redundancy pumping

All proposed changes are to be implemented through the ECM process **Error! Reference source not found..**

4. Acceptance

This document has been seen and accepted by:

Name	Designation
Kyle Enslin	Tutuka Fire Protection Engineer

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Name	Designation
Marlize Andre	Corp Specialist Plant Eng
Marius Engelbrecht	Senior Advisor Fire Risk Mng
Mbali Mathebula	Senior Technician Engineering
Lyborn Xivambu	Middle Manager Compliance

5. Revisions

Date	Rev.	Compiler	Remarks
January 2020	0	K Enslin	New document

6. Development Team

The following people were involved in the development of this document.

- Kyle Enslin
- Marlize Andre
- Lyborn Xivambu

7. Acknowledgements

NA

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Appendix A – Individual fire system details

Major System	Sub system	Minor System	Control valve	System Type	Activation Method	Nozzle/Sprinkler Data	Amount of nozzles/ sprinklers
Outside Plant	Coal Plant	O/S Conveyor 1, 2, 3, 4, 5, 6	30UY10/42/41/63/62/81/90s102	Sprinkler	Type 'F' 79°C Quartzoid Bulb		79/198/76/133/76/199/116
		Reclaim and Bottom half of Incline conveyors 1&2, 3&4, 5&6	30UY20/50/61S102	Sprinkler	Type 'F' 79°C Quartzoid Bulb		178/178/178
		Top half of incline, Cross and bottom half of B/F conveyors 1&2, 3&4, 5&6	30/03/05UY37S001	Sprinkler	Type 'F' 79°C Quartzoid Bulb		261/261/261
		Unit 1, 2, 3, 4, 5, 6 West B/F conveyors Top Half	No AKZ	Deluge	Linear Heat Detection controlling solenoid on control valve		
		Unit 1, 2, 3, 4, 5, 6 East B/F conveyors Top Half	No AKZ	Deluge	Linear Heat Detection controlling solenoid on control valve		
	West Bulk Fuel Oil Storage	Tank 1	30UY31/32S101	Deluge Foam	Manual Operation	Tank and bund pourers	5
		Tank2	30UY36/37S101	Deluge Foam	Manual Operation	Tank and bund pourers	5
	East Bulk Fuel Oil Storage	Tank 1		Deluge Foam	Manual Operation	Tank and bund pourers	5
		Tank2		Deluge Foam	Manual Operation	Tank and bund pourers	5
	West Fuel oil Plant		30UY33/34/35S102	Deluge	Pneumatic detection line rated at 79°C	#114 projector	32/30/24

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	East Fuel Oil Plant			Deluge	Pneumatic detection line rated at 79°C	#114 projector	32/30/24
	Daily Issue Oil store		30UY38S102	Deluge	Clack Type MJC rated at 79°C	#114 projector	36
	Fire pump House		00UY37S102	Deluge	Clack Type MJC rated at 79°C	#114 projector	12
	LP Services Pump house (compressors)		30UY55/56S102	Deluge	Clack Type MJC rated at 79°C	#114 projector	17
	Brine Concentration Plant						
	Lube Oil Regen and Diesel Storage Plant		10UY52S001	Sprinkler	Type 'F' 79°C Quartzoid Bulb		8
			10UY53S001	Deluge	Pneumatic detection line rated at 79°C	#114 projector	78
	Bulk Propane Vessel (West)		01UY50S103	Deluge	Pneumatic detection line rated at 79°C	#114 projector	12
	Bulk Propane Vessel (East)		06UY50S103	Deluge	Pneumatic detection line rated at 79°C	#114 projector	12
	Station Transformer		10UY81S102	Deluge	Pneumatic detection line rated at 79°C	#90 and #114 projectors	
Boiler Plant	Unit 1, 2, 3, 4, 5, 6	Cable Tunnels	01/02/03/04/05/06UY11/12/13/14/40S102	Sprinkler	Type 'F' 79°C Quartzoid Bulb		142/181/44/44/131
		Service transformers	01/02/03/04/05/06UY22S102	Deluge	Clack Type MJC rated at 79°C		67
		Boiler Burner Protection	01/02/03/04/05/06UY31/32S102	Deluge	Each valve supplies 12 Clack Type MJC's rated at 93°C with 5 nozzles	#90 and #114 projectors	60/60
Turbine	Unit 1, 2, 3, 4, 5, 6	Diesel Generator	00/01/02/03UY71S102	Deluge	Clack Type MJC rated at 79°C	#114 projectors	24
		Diesel Generator Diesel Tank	00/01/02/03UY72S102	Deluge	Clack Type MJC rated at 79°C	#114 projectors	7
		Secondary CW Pump Protection	No AKZ	Deluge	Hydraulic detection Line rated at 79°C		8

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	T&G Underfloor Protection (16m and 0m Level)	No AKZ	Sprinkler	Type 'F' 79°C Quartzoid Bulb		
	Trsfmr B	01/02/03/04/05/06UY91S102	Deluge	Pneumatic detection line rated at 79°C		13
	Gen Trsfmr	01/02/03/04/05/06UY92S102	Deluge	Pneumatic detection line rated at 79°C		52
	Gen Trsfmr	01/02/03/04/05/06UY93S102				
	Trsfmr A	01/02/03/04/05/06UY90S102	Deluge	Pneumatic detection line rated at 79°C		14
	T&G Set Zone 4 (Under steel plates on 16m Level)	01/02/03/04/05/06UY75S102	Deluge	Pneumatic detection line rated at 79°C		8
	T&G Set Zone 3 (Under steel plates on 16m Level)	01/02/03/04/05/06UY82S102	Deluge	Pneumatic detection line rated at 79°C		15
	T&G Set Zone 2 (Under steel plates on 16m Level)	01/02/03/04/05/06UY81S102	Deluge	Pneumatic detection line rated at 79°C		27
	T&G Pedestal 1	No AKZ	Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4
	T&G Pedestal 2&3		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4
	T&G Pedestal 4&5		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4
	T&G Pedestal 6&7		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4

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		T&G Pedestal 8&9		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4
		T&G Pedestal 10		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		4
		Barring Gear and Pilot excitor		Deluge	Diaphragm MJC valve with hydraulic detection line rated at 79°C		8
		T&G Set Zone 1 (Under steel plates on 16m Level)	01/02/03/04/05/06UY61S102	Deluge	Pneumatic detection line rated at 79°C		2
		T&G Lube Oil	01/02/03/04/05/06UY62S102	Deluge	Pneumatic detection line rated at 79°C		57
		BFP	01/02/03/04/05/06UY64S102	Deluge	Manual Operation		17
		BFP Lube Oil Sys	01/02/03/04/05/06UY65S102	Deluge	Pneumatic detection line rated at 79°C		19
		EFP A&B	01/02/03/04/05/06UY66S102	Deluge	Pneumatic detection line rated at 79°C		38
		T&G Fire Prot	01/02/03/04/05/06UY60S102	Deluge	Pneumatic detection line rated at 79°C		39?

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Appendix B - Fire Protection P&ID Drawings

Major System	Minor system	Sub system	Drawing Number	Title
Outside Plant	Fire Control Pumphouse		21 61/55404	Fire control pumphouse
	Potable Head Tank		21 61/55306	Common plant potable terrace storage & LP distribution system
	Air heater washing tank		21.61/55309	Common plant air heater washing tank
	Raw water supply		21 61/55225	Common plant raw water supply system
	Complete Fire system overview		0 61/9264	Schematic diagram of fire control systems and associated services
	unit 1/2/3/4/5/6 cross and bunkerfeed conveyors		21.61/55417/18/19/20/21/22s 4	Unit 1/2/3/4/5/6 boiler fire protection
	Fire pumphouse/mechanical workshop/stores		21 61/55439s1	Fire fighting water distribution
	West outside main/WTP/CW Pumphouse		21 61/55439s2	Fire fighting water distribution
	Fire Station/Station transformer/Station Diesel gen ctrl valves		21 61/55439s3	Fire fighting water distribution
	North/East/South Outside Ring Main		21.61/55439s4	Fire fighting water distribution
	Demin Pumps/compressors		21.61/55459	LPS diesel fire protection
	Lube Oil regen plant (ctrl valves)		21.61/55460s1	Lube oil and regen plant fire protection
	Lube Oil regen plant (dirty clean lube oil tank, diesel tank)		21 61/55460s2	Lube oil and regen plant fire protection
	Station transformer		21 61/55461	Station transformer protection
	Admin Building		21 61/55480	Admin building fire protection
	East Fuel Oil plant (control valves)		21 61/55493s1	East fuel oil plant fire protection
	East Fuel Oil plant (tanks and pumphouse)		21 61/55493s2	East fuel oil plant fire protection
	West Fuel Oil plant (control valves)		21.61/55500s1	West fuel oil plant fire protection
	West Fuel Oil plant (tanks and pumphouse)		21 61/55500s2	West fuel oil plant fire protection
	Daily Issue Oil Store		21 61/55501	Daily issue oil store fire protection
	Oversilo conveyors 1-3. Silo's 1-4		21 61/55502s1	Coal silos and conveyors fire prot

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	Oversilo conveyors 4-6. Silo's 5-6		21 61/55502s2	Coal silos and conveyors fire prot
	Oversilo conveyor 6 tail end protection		21 61/55502s3	Coal silos and conveyors fire prot
	Reclaim conveyors 1&2 Incline conv 1&2 tail end		21 61/55502s4	Coal silos and conveyors fire prot
	Reclaim conveyors 3&4. Incline conv 3&4 tail end		21.61/55502s5	Coal silos and conveyors fire prot
	Reclaim conveyors 5&6 Incline conv 5&6 tail end.		21 61/55502s6	Coal silos and conveyors fire prot
	Incline conveyor 1&2/ 3&4/ 5&6 head end		21 61/55509s1/s2/s3	Coal incine conveyors fire prot
	Station Diesel Generator		21 61/55678	Station diesel generator protection
	Outside Plant Control Room		21 61/55458	Common Plant outside plant control room fire prot
	MMD workshop and stores sub basement		21 61/55454s1	MMD workshop and stores sub basement fire protection system
	MMD workshop and stores ground floor		21 61/55454s2	MMD workshop and stores ground floor fire protection system
	MMD workshop and stores first floor		21 61/55454s3	MMD workshop and stores first floor fire protection system
	Brine Concentration plant			
Boiler	Unit 1/2/3/4/5/6	Boiler main and Cable tunnel sprinklers	21 61/55417/18/19/20/21/22s1	Unit 1 Boiler Fire Protection
		Service transformers	21 61/55417/18/19/20/21/22s2	Unit 1 Boiler Fire Protection
		Oil burner protection	21.61/55417/18/19/20/21/22s3	Unit 1 Boiler Fire Protection
		East propane tank (next to unit 1)		
	Unit 6	West propane tank (next to unit 6)		
Turbine	Unit 1&4, 2&5, 3&6	Diesel Generator and Diesel Tank	21 61/55585/6/7	Units 1/2/3 & 4/5/6 Diesel Generator fire protection
	Unit 1/2/3/4/5/6	Secondary CW Pump Protection		
	Unit 1/2/3/4/5/6	T&G Underfloor Protection (16m and 0m Level)		
	Unit 1/2/3/4/5/6	40MVA, 67MVA, Generator Transformer control valves	21 61/55606/7/8/9/10/11s1	Unit 1/2/3/4/5/6 generator transformer fire prot
		40MVA (unit transformer B) fire prot	21 61/55606/7/8/9/10/11s4	Unit 1/2/3/4/5/6 generator transformer fire prot
		Generator transformer fire prot	21.61/55606/7/8/9/10/11s3	Unit 1/2/3/4/5/6 generator transformer fire prot

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	67MVA (unit transformer A) fire prot	21 61/55606/7/8/9/10/11s2	Unit 1/2/3/4/5/6 generator transformer fire prot
	T&G Set Zone 2, 3, 4 (Under steel plates on 16m Level) control valves	21 61/55612/13/14/15/16/17s1	Unit 1/2/3/4/5/6 turbine fire protection
	T&G Set Zone 2, 3, 4 (Under steel plates on 16m Level) fire prot	21 61/55612/13/14/15/16/17s2	Unit 1/2/3/4/5/6 turbine fire protection
	Turbine main	21 61/55588/9/10/11/12/13s1	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	T&G Set Zone 1 (Under steel plates on 16m Level), T&G lube oil system, BFP lube oil system, EFP lube oil system control valves	21 61/55588/9/10/11/12/13s2	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	EFP oil tank and coolers	21 61/55588/9/10/11/12/13s3	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	EFP A&B fire prot	21 61/55588/9/10/11/12/13s4	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	BFPT lube oil tank fire prot	21 61/55588/9/10/11/12/13s5	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	BFPT booster and main pump fire prot	21 61/55588/9/10/11/12/13s6	Unit 1/2/3/4/5/6 turbine house fire protection distribution system
	Turbine Lube oil and FRF supply fire prot	21 61/55588/9/10/11/12/13s7	Unit 1/2/3/4/5/6 turbine house fire protection distribution system

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Appendix C - Fire Protection valve schedules

Drawing Number	Title
0.61/19000s1	FIRE PROTECTION UNIT 1-6 COMMON PLANT VALVE SCHEDULE
0.61/19000s2	UNITS 1-6 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s3	FIRE PROTECTION UNIT 1-6 COMMON PLANT VALVE SCHEDULE
0.61/19000s4	FIRE PROTECTION UNIT 1-6 COMMON PLANT VALVE SCHEDULE
0.61/19000s5	UNIT 1 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s6	FIRE PROTECTION UNIT 1 VALVE SCHEDULE
0.61/19000s7	UNIT 2 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s8	FIRE PROTECTION UNIT 2 VALVE SCHEDULE
0.61/19000s9	UNIT 3 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s10	UNIT 3 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s11	UNIT 4 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s12	UNIT 4 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s13	UNIT 5 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s14	UNIT 5 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s15	UNIT 6 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s16	UNIT 6 FIRE PROTECTION VALVE SCHEDULE
0.61/19000s17	FIRE PROTECTION UNIT 1-3 COMMON PLANT VALVE SCHEDULE
0.61/19000s18	FIRE PROTECTION UNIT 1-3 COMMON PLANT VALVE SCHEDULE
0.61/19000s19	FIRE PROTECTION UNIT 1-3 COMMON PLANT VALVE SCHEDULE
0.61/19000s20	FIRE PROTECTION UNIT 4-6 COMMON PLANT VALVE SCHEDULE

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Appendix D - Hydraulic Analysis -Isometric

0.61/55975s1	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s2	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s3	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s4	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s5	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s6	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC
0.61/55975s7	FIRE PROTECTION AUDIT HYDRAULIC ANALYSIS ISOMETRIC

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Appendix E- Generator transformer complex calculations

a) Generator transformer

Flow

$$K_{17}=2.59 \text{ lpm/kPa}^{0.5}$$

$$K_{26}=4.03 \text{ lpm/kPa}^{0.5}$$

From Tyco datasheet minimum pressure for nozzle is 350kPa

Flow through one nozzle

$$Q_{17} = k\sqrt{P} = 2.59 \times \sqrt{350} = 48.48 \text{ lpm/nozzle}$$

$$Q_{26} = k\sqrt{P} = 4.03 \times \sqrt{350} = 75.4 \text{ lpm/nozzle}$$

52 HV17 nozzles, Thus,

$$Q_{17} = 52 \times 48.48 = 2520.96 \text{ lpm}$$

25 HV26 nozzles Thus,

$$Q_{26} = 25 \times 75.4 = 1885 \text{ lpm}$$

Total generator transformer flow.

$$Q = 2520.96 + 1885 = 4405.96 \text{ lpm}$$

Add 15% more flow due to approximation.

$$Q = 4405.96 \times 1.15 = 5066.85 \text{ lpm}$$

Pressure loss

Loss in ring pipe:

$$\Delta P = 6.05 \times 10^7 \left(\frac{Q^{1.85} \times L}{C^{1.85} \times D^{4.87}} \right)$$

Where,

D=150mm

L=55m (50m measured, 5m added for bends)

Q=5066.85lpm

C=120 (From "Piping calculations manual", McGraw-Hill, E Shashi Menon)

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Thus,

$$\Delta P_{ring} = 85.47 \text{ kPa}$$

$$\text{Static Pressure} = P_{static} = 6\text{m} \times \frac{10 \text{ kPa}}{\text{m}} = 60 \text{ kPa}$$

$$\text{Required Pressure} = \Delta P_{ring} + P_{static} + P_{min} = 85.47 + 60 + 350 = 495.47 \text{ kPa}$$

$$Q_{GEN} = 5066.85 \text{ lpm}, P_{Gen} = 495.47 \text{ kPa}$$

b) Transformer A

Flow

$$K_{26} = 4.03 \text{ lpm/kPa}^{0.5}$$

From Tyco datasheet minimum pressure for nozzle is 350kPa.

Flow through one nozzle:

$$Q_{26} = k\sqrt{P} = 4.03 \times \sqrt{350} = 75.4 \text{ lpm/nozzle}$$

20 HV17 nozzles, Thus,

$$Q_{26} = 20 \times 75.4 = 1508 \text{ lpm}$$

Add 15% more flow due to approximation.

$$Q = 1508 \times 1.15 = 1734.20 \text{ lpm}$$

Pressure loss

Loss in ring pipe:

$$\Delta P = 6.05 \times 10^7 \left(\frac{Q^{1.85} \times L}{C^{1.85} \times D^{4.87}} \right)$$

Where,

D=80mm

L=50m (45m measured, 5m added for bends)

Q=1734.20 lpm

C=120 (From "Piping calculations manual", McGraw-Hill, E Shashi Menon)

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Thus,

$$\Delta P_{ring} = 228.31 \text{ kPa}$$

$$\text{Static Pressure} = P_{static} = 5m \times \frac{10 \text{ kPa}}{m} = 50 \text{ kPa}$$

$$\text{Required Pressure} = \Delta P_{ring} + P_{static} + P_{min} = 228.31 + 50 + 350 = 628.31 \text{ kPa}$$

$$Q_A = 1734.20 \text{ lpm}, P_A = 628.31 \text{ kPa}$$

c) Transformer B

Flow

$$K_{26} = 4.03 \text{ lpm/kPa}^{0.5}$$

From Tyco datasheet minimum pressure for nozzle is 350kPa.

Flow through one nozzle

$$Q_{26} = k\sqrt{P} = 4.03 \times \sqrt{350} = 75.4 \text{ lpm/nozzle}$$

20 HV17 nozzles, Thus,

$$Q_{26} = 20 \times 75.4 = 1508 \text{ lpm}$$

Add 15% more flow due to approximation

$$Q = 1508 \times 1.15 = 1734.20 \text{ lpm}$$

Pressure loss

Loss in ring pipe:

$$\Delta P = 6.05 \times 10^7 \left(\frac{Q^{1.85} \times L}{C^{1.85} \times D^{4.87}} \right)$$

Where,

$$D = 80 \text{ mm}$$

$$L = 45 \text{ m (40m measured, 5m added for bends)}$$

$$Q = 1734.20 \text{ lpm}$$

$$C = 120 \text{ (From "Piping calculations manual", McGraw-Hill, E. Shashi Menon)}$$

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Thus,

$$\Delta P_{ring} = 205.48 \text{ kPa}$$

$$\text{Static Pressure} = P_{static} = 5m \times \frac{10 \text{ kPa}}{m} = 50 \text{ kPa}$$

$$\text{Required Pressure} = \Delta P_{ring} + P_{static} + P_{min} = 205.48 + 50 + 350 = 605.48 \text{ kPa}$$

$$Q_B = 1734.20 \text{ lpm}, P_B = 605.48 \text{ kPa}$$

Flow Correction

$$Q_1 = \sqrt{\frac{HP}{LP}} \times LPQ = \sqrt{\frac{628.31}{495.47}} \times 5066.85 = 5705.80 \text{ lpm}$$

$$Q_1 = \sqrt{\frac{HP}{LP}} \times LPQ = \sqrt{\frac{628.31}{605.48}} \times 1734.20 = 1766.59 \text{ lpm}$$

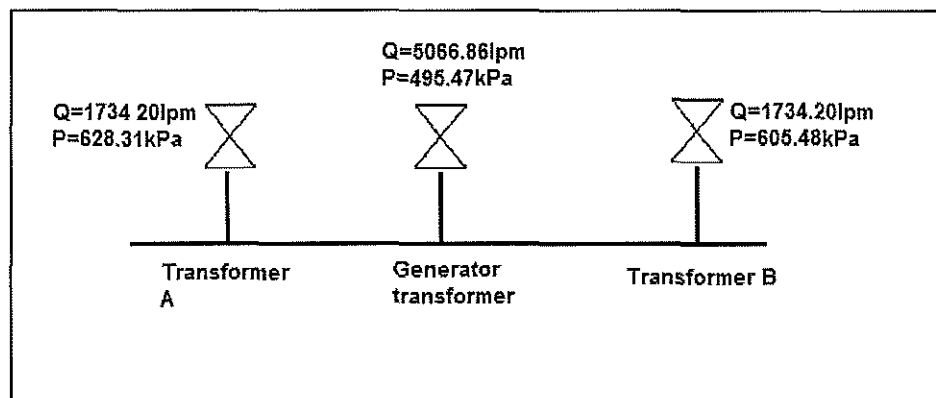


Figure 7-1: Uncorrected flows and pressures (gen transformer complex)

Table 7-1: Summary of Gen transformer Q and P

System	Flow (lpm)	Pressure (kPa)	Flow Correction	
			Q (lpm)	P
Generator Transformer	5066.85	495.47	5705.80	628.31 kPa

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Transformer A	1734.20	628.31	1734 20	628.31kPa
Transformer B	1734.20	605.48	1766.59	628.31kPa
TOTAL	8535.25	628.31		
Worst case requirement (with flow correction)			9206.59	628.31kPa

Pressure loss

Loss in supply from pump house.

$$\Delta P = 6.05 \times 10^7 \left(\frac{Q^{1.85} \times L}{C^{1.85} \times D^{4.87}} \right)$$

Where,

D=350mm

L=1000m (assumed)

Q=9206.59 lpm

C=120 (From "Piping calculations manual", McGraw-Hill, E Shashi Menon)

$$\Delta P_{supply} = 75.73kPa$$

Required Q=9206.59 lpm

Required P=628.31+75.73=704.04kPa

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Appendix F– Turbine underfloor calculations

Based on the solid mezzanine levels below the generator it was decided that from [4] the most applicable scenario would be 2.4.3.3 (Solid Operating Floor with Solid Mezzanine).

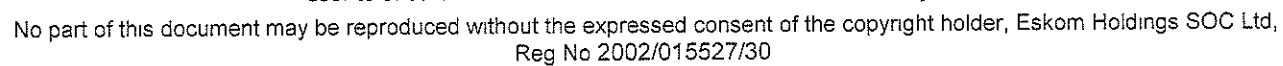
Since isometrics were not available of this system, the plant was walked and rough isometrics developed (Figure 7-2 and Figure 7-3)

The results are summarised in Table 7-2.

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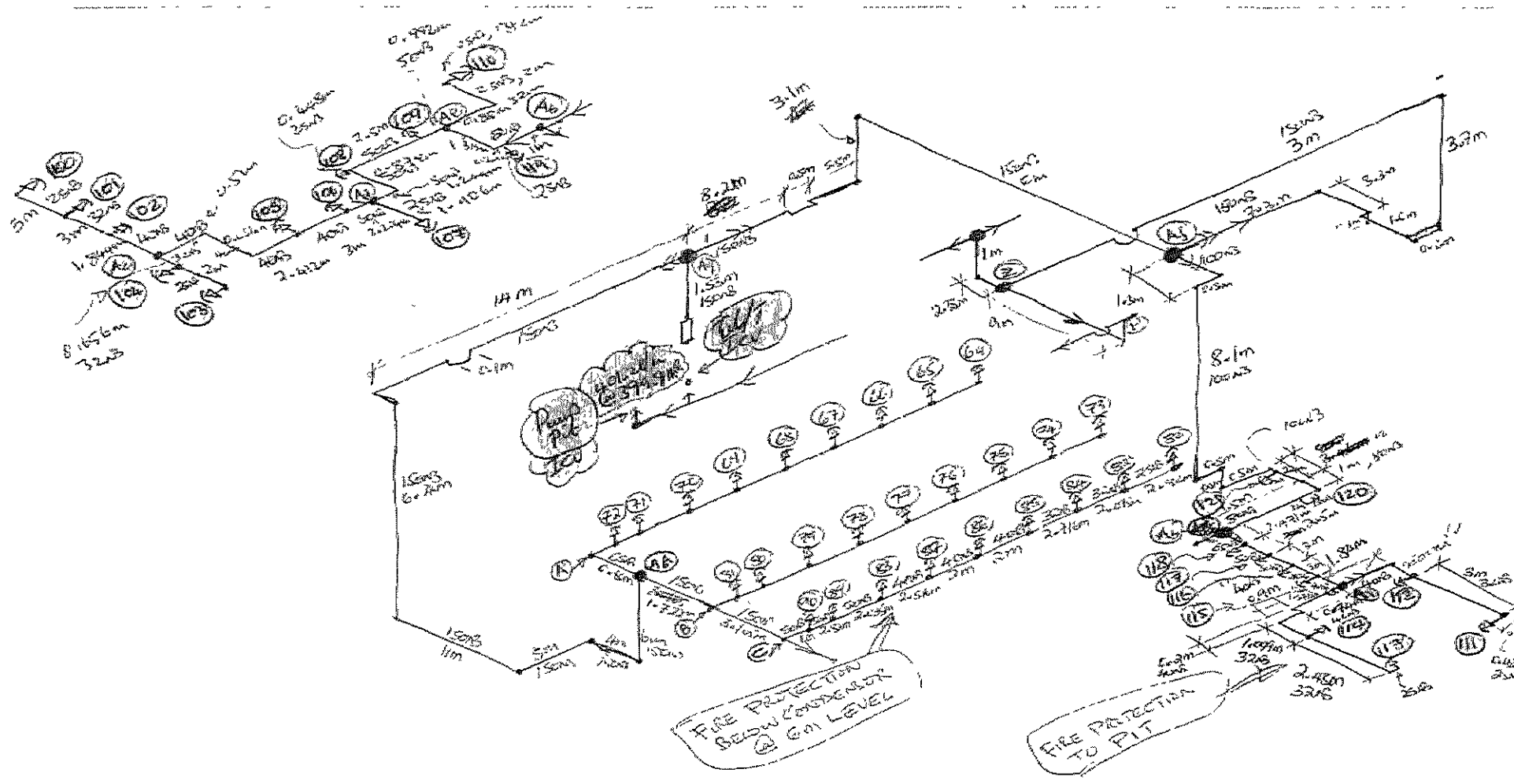


Figure 7-3: Turbine Underfloor Protection Isometric (2 of 2)

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Table 7-2: Summary of results

Flow and pressure at Junction W	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe V-W	849.63	55.59	849.63
Pipe J-W	1517.05	49.31	1610.67
Total	2366.67	55.59	-
Junction W	-	55.59	2460.30

Flow and pressure at Junction S	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe L-S	176.32	63.38	295.57
Pipe R-S	913.05	178.11	913.05
Pipe W-S	2460.30	102.31	3246.23
Total	3549.66	178.11	-
Junction S	-	178.11	4454.85

Flow and pressure at Junction N	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe L-N	172.67	57.12	258.87
Pipe K-N	821.04	128.39	821.04
Pipe U-N	849.63	80.96	1069.91
Total	1843.34	128.39	-
Junction N	-	128.39	2149.82

Flow and pressure at Junction Z	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe S-Z	4454.85	430.60	4454.85
Pipe N-Z	2149.82	213.46	3053.40
Total	6604.66	430.60	-
Junction Z	-	430.60	7508.25

Flow and pressure at Junction Af	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe Z-Af	7508.25	554.34	7508.25
Pipe 121a-Af	2044.76	206.26	3352.19
Total	9553.01	554.34	-
Junction Af	-	554.34	10860.44

Flow and pressure at Junction Ag	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe Af-Ag	10860.43	792.65	10860.43

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Tutuka Fire Protection Demand -Worst Case Scenario

Unique Identifier **15GEN ENG-751**

Revision **1**

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Pipe AA-Ag	2281.20	295.01	3739.29
Total	13141.63	792.66	-
Junction Ag	-	792.66	14599.73

Flow and pressure at Junction Ag	Q(ℓ/min)	P (kPa)	Q(ℓ/min) Corrected
Pipe Ag-ICV Under Turbine	14599.73	831.27	14599.73
Pipe ICV PumpPit	401.20	399.91	578.43
Hydrants x 2	2400.00	350.00	3698.69
Total	15000.93	831.27	-
Junction Split	-	831.27	18876.85

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