Artemis Power Plant Operation

User Manual

Version 0.1

30/07/2023

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1. Introduction

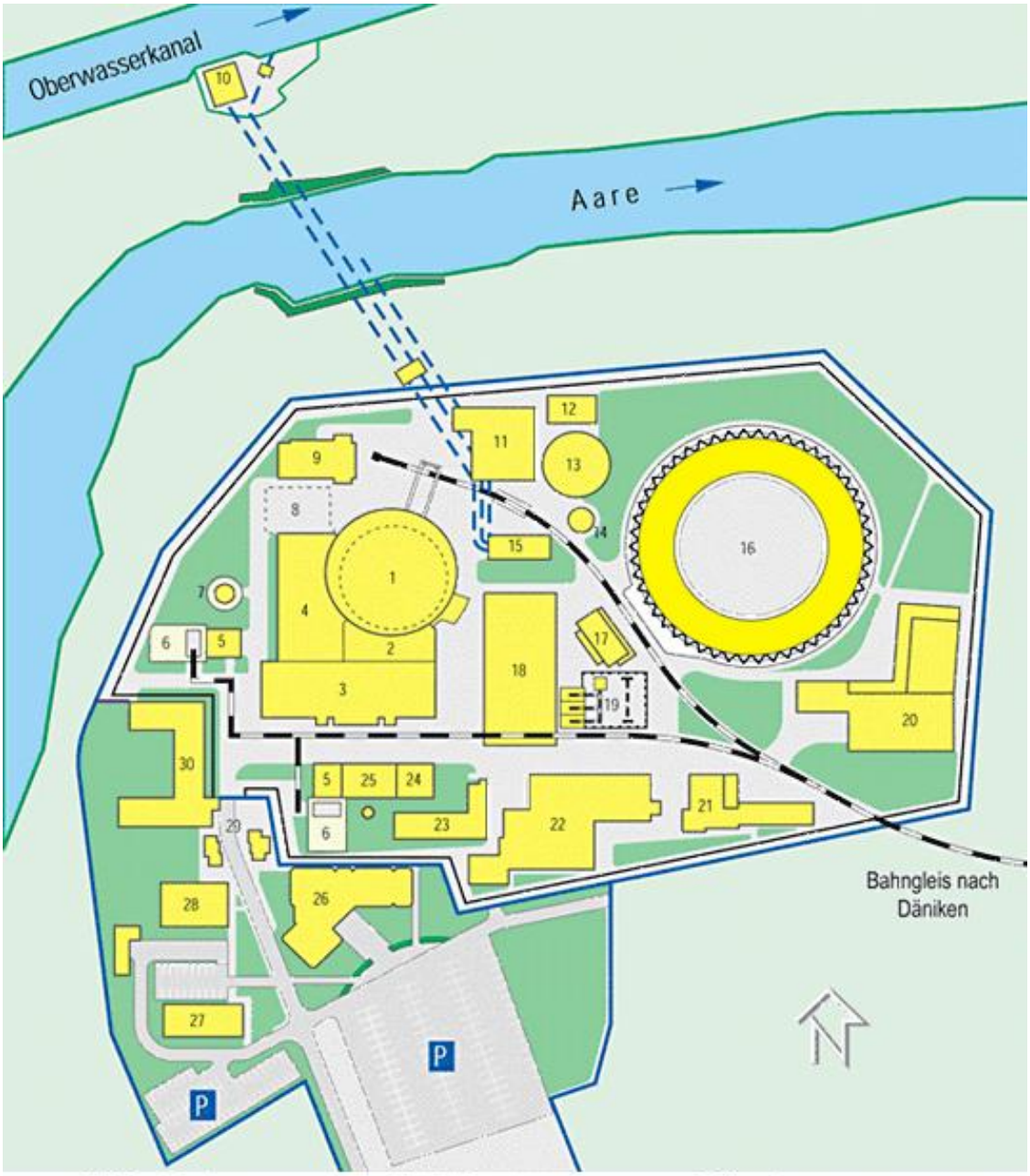
This User Manual (UM) provides the information necessary for apprentice operators or experienced operators to safely operate the Artemis Power Plant. This public document aims to give a complete and precise knowledge of this power plant control room.

Side note: As English isn't my mother tongue, this document might contain language mistakes which can be reported via SuperSurvivalX' official Discord.

1.1 Overview

The following figure shows a map of the power plant so that you can easily navigate to the correct building quickly.

Image 1 – Plant map



1 Bâtiment réacteur
2 Bâtiment d'alimentation de secours
3 Bâtiment des installations électriques
4 Bâtiment des auxiliaires nucléaires
5 Bâtiments des groupes électrogènes de secours
6 Transformateurs d'alimentation extérieure 220 kV
7 Cheminée de ventilation
8 Entrepôt pour déchets de faible et de moyenne activité
9 Bâtiment de secours
10 Station de prise d'eau
11 Installation de déminéralisation
12 Stockage des boues
13 Décanteur/Précipitateur de calcaire
14 Epaississeur de boues
15 Station de pompage d'eau de refroidissement auxiliaire
16 Tour de réfrigération
17 Station de pompage du circuit principal de refroidissement
18 Salle des machines
19 Transformateurs de réseau 400 kV
20 Magasin
21 Poste incendie et garages
22 Atelier et magasin de pièces de rechange
23 Magasin en rayonnages
24 Préparation de l'eau
25 Chaudière auxiliaire et centrale de chauffage
26 Pavillon des visiteurs
27 Bâtiment de formation et du simulateur
28 Restaurant du personnel
29 Zone d'accès
30 Bâtiment administratif

Table X – Translation of the previous points:

1	Reactor building	11	Water treatment unit	21	Fire station and garages
2	Emergency power building	12	Mud disposal	22	Replacement pieces workshop
3	Electrical facilities building	13	Chalk remover	23	Storage
4	Nuclear auxiliaries building	14	Mud thickener	24	Water preparation
5	Diesel generators building	15	Auxiliary cooling water pumps building	25	Heating unit and auxiliary boiler
6	220 kV external power transformer	16	Cooling tower	26	Visitors building
7	Venting chimney	17	Primary cooling water pumps building	27	Training building
8	Low & medium activity waste disposal	18	Machine room	28	Worker's cantina
9	Emergency building	19	400 kV grid transformer	29	Entrance
10	Pumping station	20	Storage	30	Administration building

The following diagram shows all the original systems of the plant. Note that the actual systems are simplified for accessibility reasons.

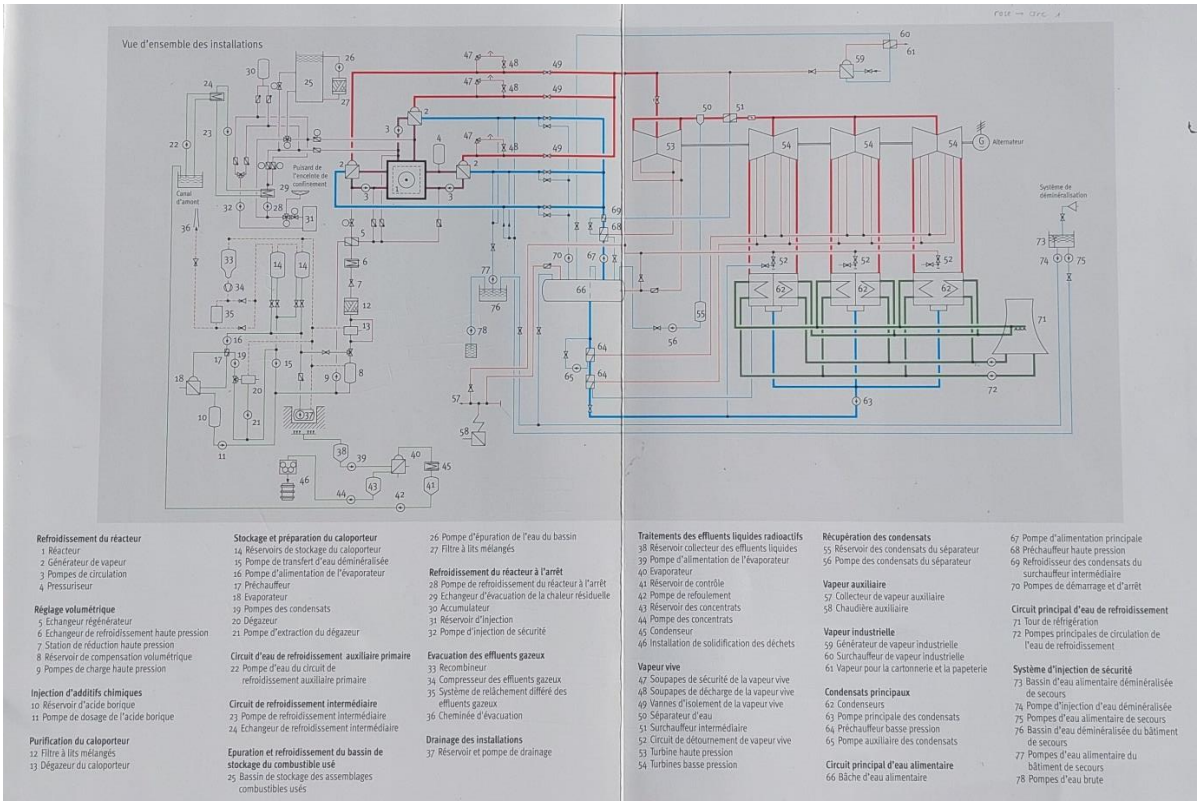


Table X – Translation of the previous points:

1	Reactor	40	
2	Steam generator	41	

3	Circulation pump	42	Delivery pump
4	Pressurizer	43	Concentrate tank
5	Regenerator exchanger	45	Condenser
6	High pressure cooling exchanger	46	Wastes solidification unit
7	High pressure reduction unit	47	Steam safety valve
8	Voluminal compensation reservoir	48	Steam discharge valve
9	High pressure load pumps	49	Steam isolation valve
10	Boric acid reservoir	50	Water separator
11	Boric acid dosing pump	51	Intermediate over-heater
12	Mixed beds filter	52	Steam diversion circuit
13	Coolant degasser	53	High pressure turbine
14	Coolant storing reservoir	54	Low pressure turbine
15	Deionized water transfer pumps	55	Separator’s condensate tank
16	Evaporator feed pump	56	Separator’s condensate pump
17	Preheater	57	Auxiliary steam collector
18	Evaporator	58	Auxiliary boiler
19	Condensates’ pumps	59	Industrial steam generator
20	Degasser	60	Industrial steam over-heater
21	Degasser extraction pump	61	Steam for cardboad and stationery
22	Too big to translate lol	62	Condenser
23	Intermediate cooling pump	63	Primary condensates pump
24	Intermediate cooling exchanger	64	Low pressure pre-heater
25	Spent fuel storage pool	65	Auxiliary condensates’ pump
26	Pool purification pump	66	Feed water tank
27	Mixed beds filters	67	Primary feeding pump
28	Offline reactor cooling pump	68	High pressure pre-heater
29	Residual heat exchanger	69	Intermediate over-heater condensates cooler
30	Accumulator	70	Start and stop pumps
31	Injection reservoir	71	Cooling tower
32	Security injection pump	72	Primary cooling water circulation pumps
33	Recombiner	73	Emergency deionized water feeding pool
34	Exhaust gas compressor	74	Deionized water injection pump
35	Off-gas delayed release system	75	Emergency feeding pumps
36	Evacuation chimney	76	Emergency building deionized water pool
37	Reservoir and drainage pump	77	Emergency building water pumps
38	Liquid effluent collection tank	78	Raw water pumps
39	Evaporator feeding pump		

2. Access to the control room

Until the powerplant isn't fully built, the control room can be accessed from the build number 26. It requires at least the **@||Un-licenced Operator||** rank to access it and at least the **@||Apprentice Operator||** rank to interact with the control room's panels. Also note that every entry and exit is logged to know who was inside the room in case something goes wrong.

2.1 Cautions & Warnings

Operating the reactor should be fun and entertaining but it requires a minimum of serious in order to create a friendly and welcoming atmosphere. So all global rules of the server applies in this case and any abuse can get punished.

2.2 Ranks

To keep the operation of the plant in safe hands each worker has a rank that defines his level and permissions. Those are the ranks available:

1. **@||Un-licenced Operator||**

   This is the rank given to all new students who passed the theorical exam. This grants you the access to the control room, but you can't interact with it.

2. **@||Apprentice Operator||**

   After following a first control room tour lesson, you will graduate to this rank and get the permission to interact with the buttons in the control room. But you won't be able to act freely as every action will have to be authorized by a senior operator or an operations director.

3. **@||Reactor-Operator||**

   The operator rank is given after completing a practical exam with a senior operator or an operations director in which you will have to startup the reactor, push it to 100% power production and finally shut it down.

4. **@||Senior Operator||**

   Unlocking this rank requires you to have an interest in teaching reactor operations and four attendance certificates. Once done, you will teach the apprentices how to operate the reactor by giving them the tools required to pass the exam.

5. **@||Operations Director||**

   Requiring 10 certificates of attendance, this rank is reserved to the most dedicated operators. Operations director can write new procedures, are the leaders of every reactor test and manage new operators' admissions. Their orders must prevail in the control room and can revoke your access to the control room.

All exams are available on the official SuperSurvivalX website: *supersurvivalx.webador.ch*

2.3 Before entering

Outside the control room you will find a hopper in which you will have to deposit a book and quill before entering the control room for operations (if you aren't part of the shift then you don't have to). The book must apply to the following criteria's':

- The book mustn't be signed.
- The book must contain the date (day/month/year) of your shift.
- The book must contain your Minecraft & Discord name as text.
- If you can add more detail about the operations that you will be doing in the control room, then write it down.

If you don't give that book, your attendance will also be logged. But if the operations director forgets to do it and you don't have solid proofs of your presence, it won't be possible to log your presence. But if you leave that book, operations directors will be able to log your presence even if there is a problem.

2.4 Control room areas

Inside the control room you will see a bunch of different pannels with different signals that are listed and explained here.

2.4.1 Reactor & turbines' panel

From left to right:

- **Manual water flow**

The first loop is manually cooled with external means like firetrucks or auxiliary pumps.

- **Spent fuel pool pump 1**

  Cools the spent fuel pool. It requires at least one pump turned on in the first loop to operate.

- **Emergency core discharge valve**

  It releases the pressure into the confinement building but contaminates it. During normal operation, this can cause a loss of coolant but can prevent a major explosion in case of emergency.

- **Steam generator valve 1,2 & 3**

  Transfer heat to the other loops and enables the ability to cool the reactor and transfer energy to turbines.

- **Core circulation pump 1,2 & 3**

  Set the speed of the water inside the core. Not enough and the reactor overheats and too little and the reactor won't produce enough heat.

- **Loop 1 breach**

  It indicates that coolant is being lost and the reactor can't be cooled properly.

- **Pressurizer**

  Unless something malfunctions, the pressurizer is always on and automatically regulates the pressure inside the first loop to maintain the reactor under control.

- **Core meltdown**

  This warning will indicate when the reactor is melting due to overheating.

- **Loop 2 discharge valve**

  Will discharge the pressure in the second loop to prevent any damage to the turbinesand condensers. This is used in case of emergency if the steam generators are producing to much steam for the 2nd loop to handle.

- **Empty core circulation pump**

  During maintenance, this manual pump provides enough flow to keep the spent fuel pool cooled when the reactor is empty and dry.

- **Raw water pumps**

  Pump water into the river for the 2nd loop (and 3rd but it doesn't impact it). Water treatment is automatical and don't require any operation.

- **Loop 2 pumps**

  Pumps for the 2nd loop.

- **Turbine 1, 2, 3 & 4**

  Each turbine requires 1 steam generator on and 1 capacitor valve. When 3 steam generators and 3 capacitor valves are operating, turbine 4 can also be activated at the same time as turbine 3.

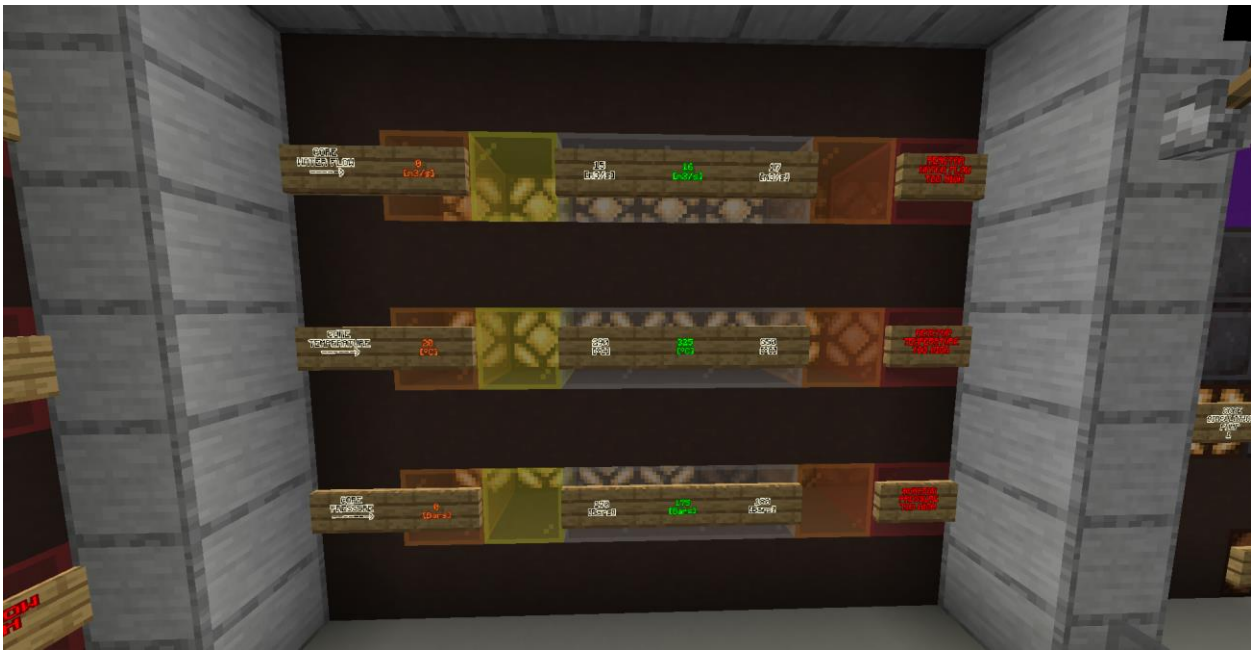
- **Condenser valve 1, 2 & 3**

After the steam goes through the turbine, it must access the condensers, where the steam condenses and gets ready to take heat from 1st loop. This valve is used to operate the access to the condensers.

- **Loop 2 breach**

  If water is lost in the 2nd loop, this alarm will fire and warn the operator that the 2nd loop wont transfer water properly and that turbines or cooling may fail. The reactor must be shut down to prevent any meltdown.

2.4.2 Core panel



- **Core water flow**

  Indicates how much water is currently flowing through the core.

- **Core temperature**

  Self explanatory.

- **Core pressure**

  The pressure is calculated with the temperature and the water flow, if the water flows is high and there's not enough heat generated, the pressure wil be low and if the temperature is high with little water flow, the pressure will be high.

2.4.3 Water flow panel

- **Spent fuel pool temperature**

  The temperature of the spent fuel is cool when the first core circulation pump is on. Else the temperature rises and if can cause major problems and radiations.

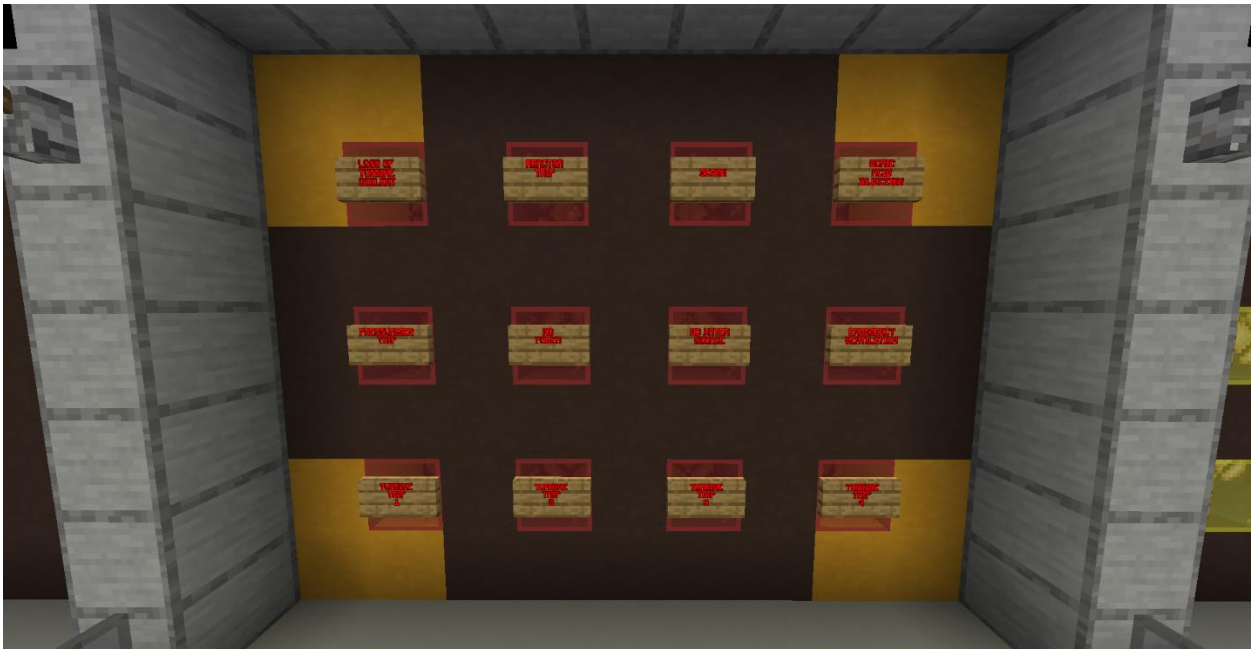
- **2nd loop water flow**

  The 2nd loop is the one for the turbines.

- **3rd loop water flow**

  The 3rd loop is the one for the cooling tower.

2.4.4 Alarm's panel



- **Loss of turbine coolant**

  The turbine hydrolics are no longer working properly. This can damage the turbines if they aren't stopped fast enough.

- **Reactor trip**

  The reactor is malfunctioning due to a too high pressure or temperature.

- **SCRAM**

  The emergency control rod insertion has been manualy or automaticaly activated.

- **Boric acid injection**

  The reactor is filled with boric acid and is permanently dead.

- **Pressurizer trip**

  The pressurizer is broken and pressure & core water flow will drop.

- **No power**

  Every alectrical componant of the plant is off due to a lack of electrical supply.

- **No water source**

  The 2nd loop isn't fed with water and the reactor is no longer cooled.

- **Emergency ventilation**

  The pressure is so high that some pressure must be released. This can release radioactive isotops in the atmosphere and nearby population must be warned before hand.

- **Turbine trip 1, 2, 3 & 4**

A turbine isn’t working as intended and must be stopped before important damage is dealt.

2.4.5 Controls’ panel

- **Maintenance mode**

  The reactor is under maintenance and some systems might not work. This unlocks special systems to open the core for example. Maintenance are directed by operations directors and no one else.

- **Computer off**

  Informational messages are diasbled for a cleaner chat.

- **Master alarm**

  It fires when an orange warning light is on. It’s generaly not to worry about but requires special attention.

- **Aknowledge core relief valve**

  Stops the linked alarm.

- **Aknowledge turbine trip**

  Stops the linked alarm

- **Reset SCRAM**

  Reload the mechanical SCRAM system and releases the rods so they can be operated again.

- **Lights**

Turn On/Off the lights in the control room. Chose what you like the most but don't forget that turning the lights on can indicate you if there's a power loss.

2.4.6 Auxiliaries' panel

- **Automatic APU startup**

  The APU will automaticaly startup when power is unstable or lost.

- **Manual switch activated**

  A manual command is overriding the control room and might cause issues if it wasn't intended.

- **No fuel in core**

  No fuel rods in the core. The reactor cannot work.

- **Manual power input**

  The power is provided with some external equipment like small portable generators.

- **Connection to the grid**

  The power generated is sent to the grid.

- **Manual water circulation**

  Water is pumped with auxiliary portable pumps like firetrucks for example.

2.4.7 Power panel

- **Importing power**

  The powerplant is using grid power to work.
- **Powerplant power**

  The powerplant can supply itself enough power to be independent from the grid.
- **APU power**

  APU is providing the power to the plant.
- **Grid power unavailable**
- **Core power unavailable**
- **APU power unavailable**
- **APU ready for startup**

  The APU is ready to start with enough fuel and no technical issue.
- **APU running**

  APU is generating power.
- **APU fuel low**
- **Emergency APU ready for startup**
- **Emergency APU running**
- **Emergency APU fuel low**

2.4.8 Control rods' panel

2.4.9 3rd loop panel

- **Turbine turning gear**

  Turbine will not show on the panel if it's off. The turning gear connects the turbines to the exciter, which generates electricity. Without it the turbines will just spin without making power. It can be useful to protect electrical components used to connect to the grid.

- **Cooling tower valve**

  Open or close the access to the cooling tower and the 3rd loop pumps.
- **Cooling tower pump 1 & 2**
- **Loop 3 breach**

2.5 Exiting the control room

Before exiting the control room make sure that the reactor is stable and won't change when you are away. To count water and heat levels it uses items and by going away there's a risk that those items will despawn. Also, some pistons might get budded if you exit while they are moving so please pay attention before leaving.

3. Operating the plant

If applicable, include sub-sections to describe and depict all standard and/or ad hoc report capabilities available to the end user and any associated user procedures. Include formats for each available report and the meaning of each field shown on the report. Also describe any special formats associated with ad hoc reports that the user may be able to create. Provide detailed instructions for executing and printing the different reports that are available. Include descriptions of output procedures, identifying output formats and specifying the output's purpose, frequency, options, media, and location.

3.1 Effective and potential thermal unit

These are 2 important notions for measuring how fast the reactor is heating/cooling. Many parts of the plant have an impact on the cooling/heating of the reactor such as pumps or steam generators and we measure their efficiency with two custom units: Effective and potential thermal unit (ETU and PTU for short). The resultant ETU is called "H" and represents the cooling/heating speed and the PTU represents ETU that can be gained.

Table X – ETU values

Loop 1, 2 & 3 water flow	-1 ETU / Lamp (only lowest water flow is effective)
Core circulation pumps	-2 PTU / Pump
1 pump in loop 3	-2 PTU
2 pumps in loop 3	-4 PTU
Loop 2 pumps	-6 PTU
Steam generators	Each one unlocks 2 ETU from loop 1 & 2
33% rod withdrawal	+1 ETU
66% rod withdrawal	+2 ETU
100% rod withdrawal	+2 ETU

Table X – H speeds

H = -3	V2 Cooling
H = -1	V1 Cooling
H = 0	Stable
H = 1	V1 Heating
H = 3	V2 Heating

Steam generators requirements

Let's call the number of core temperature lights "N". The formula that gives the number of steam generators allowed to work is:

N + 3 - ETU of loop 1

If the result goes beyond 3, it reduces the number of steam generators. For example, if it's 4, the number of SGs is 2.

H = 5	V3 Heating
H = 6	V4 Heating
ETU = -6	V1 Cooling

(With H = $\sum_{ETU}$)

Turbines requirements

1 turbine requires 1 steam generator and 1 open condenser valve. Once 3 SGs and 3 condenser valves are working, turbine 4 can be turned on.

3.2 Communications

When operating the plant, we use a request and reply system. That means that the operations director asks for certain checks or systems to be switched and the operator in charge of this task confirm that the request has been fulfilled.

It is advised to write those messages somewhere so in case of an accident we can easily find the error committed by the shift. But it's not mandatory.

Example:

- OP director: "Wait for temperature at X°C."

Operator waits on the temperature to reach the desired value

- Operator: "Temperature at X°C."

3.3 Procedures

Those are check lists used to set the plant with the correct settings in each common situation. **Read the left column first!**

3.3.1 Default settings

These parameters are to be checked when the reactor is Off and before startup. Before verifying it, make sure that no warning lights or alarms are on.

System	Value	Check	System	Value	Check
Core Temperature	20°C		Turbine valves	Off	
Lower Production	Off		Cooling tower pumps	Off	
Emergency APU	Off		Cooling tower valve	Off	
APU	Off		2nd loop pumps	Off	
Power source	Import		Raw water pumps	Off	

Auto startup	Off		Condensers valves	Off	
SCRAM	Operational		Core circ. pump 1	On	
Control rods	0% out		Core circ. Pump 2 & 3	Off	
Steam generator valves	Off		Core water flow	Yellow mark	
2nd loop relief valve	Off		Loop 2 & 3 water flow	0 m^3/s	
Emergency core relief valve	Off		Computer	On	
Turbine brakes	Operational		Mute alarms	Off	
Turning gear	Off		Maintenance mode	Off	
Turbine hydrolics	Off				

3.3.2 Startup to 33%

To startup the reactor, first apply the following settings:

System	Value	Check	System	Value	Check
Auto APU startup	On		Cooling tower pump 1	On	
Steam generator 1	On		Raw water pumps	On	
Turbine Hydraulics	On		2nd loop pumps	On	
Cooling tower valve	On		Core circulation pump 1	On	

Note that all water flows are to stay at 0 m^3/s at this moment.

Setting the water flows

As the first pump requires 290 [°C] we need to first heat up the reactor and as we reach this value, we must quickly stabilize the reactor. We can first setup the water flows.

System	Value	Check	System	Value	Check
2nd loop water flow	25 [m^3/s]		3rd loop water flow	32 [m^3/s]	
1st loop water flow	0 [m^3/s]		Capacitor valve 1	On	

Heating steps:

i) Pull the rod 33% out.
ii) Wait until the temperature = 290 [°C].
iii) Quickly (X [s] time frame) set 1st loop water flow on <15 [m^3/s].
iv) Wait X [s] and check the temperature.
v) Possible outcomes:
    (1) The temperature stayed the same => continue
    (2) The temperature went down:
        (a) Restart from the very beginning
        (b) If you reach this point a second time, scram the reactor and report the issue to an admin
    (3) The temperature went up:
        (a) Set the control rods on 0% out.
        (b) Wait until the temperature = 290 [°C].
        (c) Pull the rod 33% out.
        (d) Go back to step (iv)
vi) You can now start turbine 1.

The reactor is now operating at 33% of heating power and 25% of the nominal power, which is 400 [Mw/h].

3.3.3 Powering up to 66%

Prerequisites

The procedure to 33% of nominal power has been done without any issue and the reactor has been stabilized.

Setting the water flows

System	Value	Check	System	Value	Check
Cooling tower pump 2	On		Core circ. pump 2	On	
1st loop water flow	<15 [m^3/s].		3rd loop water flow	34 [m^3/s]	
2nd loop water flow	3 [m^3/s]		Capacitor valve 2	On	

Heating steps:

1) Pull the rod 66% out.

2) Wait until the temperature = 325 [°C].
3) Quickly (X [s] time frame) set 1st loop water flow on 16 [m^3/s].
4) Wait X [s] and check the temperature.
5) Possible outcomes:
   a) The temperature stayed the same => continue
   b) The temperature went down:
      i) Restart with the above parameters.
      ii) If you reach this point a second time, scram the reactor and report the issue to an admin
   c) The temperature went up:
      i) Set the control rods on 33% out.
      ii) Wait until the temperature = 325 [°C].
      iii) Pull the rod 66% out.
      iv) Go back to step 4)
6) You can now start turbine 2.

3.3.4 Powering up to 100%

Prerequisites

The procedure to 66% of nominal power has been done without any issue and the reactor has been stabilized.

Setting the water flows

System	Value	Check	System	Value	Check
Core circ. pump 3	On		2nd loop water flow	> 3.5 [m^3/s] (orange)	
1st loop water flow	16 [m^3/s].		3rd loop water flow	> 36 [m^3/s] (orange)	
Capacitor valve 3	On				

Heating steps:

1) Pull the rod 100% out.
2) Wait until the temperature = 350 [°C].
3) Quickly (X [s] time frame) set 1st loop water flow on > 17 [m^3/s] (orange light).
4) Wait X [s] and check the temperature.
5) Possible outcomes:
   a) The temperature stayed the same => continue
   b) The temperature went down:

i) Restart with the above parameters.
ii) If you reach this point a second time, scram the reactor and report the issue to an admin

c) The temperature went up:
i) Set the control rods on 66% out.
ii) Wait until the temperature = 350 [°C].
iii) Pull the rod 100% out.
iv) Go back to step 4)

6) You can now open steam generator valve 2 and start turbine 3.

3.3.5 Starting the last turbine

1) Set the 1st loop water flow on 17 [m^3/s].
2) Wait until the core temperature is > 350 [°C] (orange).
3) Bring the 1st loop water flow back on > 17 [m^3/s] (orange light).
4) Open the 3rd steam generator valve.
5) Open the 4th turbine valve.

4. Troubleshooting & Support

Operation of the plant is always evolving and the redstone systems are always improved but sometimes, unexpected issues happen. You will find all necessary information about this topic under this section.

4.1 Error Messages

4.2 Special Considerations

The control room might go under maintenance and some functionalities may not work as intended. Before operating the plant, please watch for any sign in the control room or wool in front of a lever/button that might indicate something's out of use.

4.3 Support

Assistance can be given by an operator of the same shift or via a discord ticket under: Help > #support-1

Appendix A: Glossary

This table provides clear and concise definitions for terms used in this document that may be unfamiliar to readers of the document. Terms are listed in alphabetical order.

Table 3 - Glossary

Term	Acronym	Definition
Auxiliary Power Unit	APU	Diesel generators that produce power in case of emergency.
Control Room	CR	The place where the reactor is operated.
Nuclear Power Plant	NPP	A power plant using atoms' power to produce energy.
Pressurized Water Reactor	PWR	A type of reactor which is often used nowadays.
Single Cutting Rope Axe Man	SCRAM	A system that drops all control rods into the reactor. This term comes from the early reactors in which this action was manually done.
Steam Generator	SG	Transfer high temperature from 1st loop to the 2nd loop as steam.

Appendix B: Referenced Documents

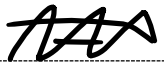
Table 4 - Referenced Documents

Document Name	Document Location and/or URL
<Document Name>	*<Document Location and/or URL>*
<Document Name>	*<Document Location and/or URL>*
<Document Name>	*<Document Location and/or URL>*

Appendix C: Approvals

The undersigned acknowledge that they have reviewed the User Manual and agree with the information presented within this document. Changes to this User Manual will be coordinated with, and approved by, the undersigned, or their designated representatives.

Table 5 - Approvals

Document Approved By	Date Approved
 . Name: Deimos, Admin of SuperSurvivalX	

Appendix D: Notes to the Author/Template Instructions

This template was designed based on best practices and information to support CMS governance and IT processes. Use of this template is not mandatory, rather programs are encouraged to adapt this template to their needs by adding or removing sections as appropriate. Programs are also encouraged to leverage these templates as the basis for web-based system development artifacts.

- *Each section provides instructions or describes the intent, assumptions, and context for content included in that section. Instructional text appears in blue italicized font throughout this template.*
- *When using this template, follow these steps:*
  1. *Table captions and descriptions are to be placed left-aligned, above the table.*
  2. *All documents must be compliant with Section 508 requirements.*
  3. *Figure captions and descriptions are to be placed left-aligned, below the figure. All figures must have an associated tag providing appropriate alternative text for Section 508 compliance.*