

Universal RBWR

Malfunction Repair Guide



UPDATED FOR RBWR VERSION 1.5.0

Writer:

Inspector 5Vibesss (5Vibess)

Special Thanks To:

Inspector Dopar (Dopardinho)

Nuclear Engineer Critical_Paul (legalize_nucbombs69)

RBWR Developer Anticitizen One (mrkesselring)

Senior Inspector AstonProb (AstonProb)

Head RBWR Developer Tooken (tookendev)

Senior Inspector samchaster46 (samchaster46)

Instructor Strontium-90 (euphoniumuser)

Document made for **Roblox RBWR**, created by **DelfinoDelphis**

This document may contain inaccuracies and is subject to change at any time
Any suggestions are welcome at @5Vibesss on Discord

PREFACE

This guide is not meant to be read entirely from start to end, it is meant to explain how to detect and repair various malfunctions.

This guide additionally does not account directly for pump lag which is present in U2.

Utilize the below Table of Contents to redirect straight to any malfunction to see how to identify and fix them.

TABLE OF CONTENTS

Reactor Recirculation Panel	4
Recirculation Pumps ^{1/2}	4
Condenser Control Panel	5
Steam Jet Air Ejectors ^{1/2}	5
Condenser Circulation Pumps ^{1/2}	6
Main Cooling Circuit Panel	7
Feedwater Pumps ^{1/2}	7
Condensate Pumps ^{1/2}	8
Preheaters ^{1/2/3}	8
Leak After Hotwell.....	9
Leak After Deaerator.....	9
U2 Turbine Control Room	10
Turbine Hydraulic Oil Leak.....	10
Oil Filter Replacement.....	10

Reactor Recirculation Panel

Recirculation Pump Malfunction

- Details:** The recirculation pumps are vital to controlling the power of the reactor. Due to this, a malfunction within one or both recirculation pumps can throw off the power of the reactor.
- Identification:**
- φ The output of each of the recirculation pumps is linear in that for every ~1% of setpoint the pump will output ~5kg/s of flow.
 - φ The formula $[\text{SETPOINT}\%]*5$ will give the expected flow of the pump.
- Example:** If you have recirculation pump 1 at a setpoint of ~34.2%, then you should do $34.2*5$ which will equal ~171kg/s. This means that recirculation pump 1 should be running at ~171kg/s if it is healthy, and if it isn't then it is malfunctioning.
- Solution:** Lower the setpoint of the malfunctioning pump(s) slowly to 0 so you can substitute the lost power from the broken recirculation pump(s) with either additional rod pulling, or increasing the setpoint of the other recirculation pump if it is functional. Once the pump is at 0 disable it and tag it.

Expected output value at certain setpoints:

1% setpoint	~5kg/s output
5% setpoint	~25kg/s output
10% setpoint	~50kg/s output
28.8% setpoint	~144kg/s output
50% setpoint	~250kg/s output
100% setpoint	~500kg/s output

Condenser Control Panel

Steam Jet Air Ejector Malfunction

- Details:** The steam jet air ejectors (SJAE) is a core system in attaining and keeping a vacuum within the condenser. Due to this, a malfunction within an active steam jet air ejector could throw the vacuum off.
- Identification:**
- φ Detecting a malfunction within the SJAEs can be tedious but it is possible!
 - φ To do so you must first make sure that the reactor and turbine pressure are stable.
 - φ Once the condenser vacuum is stable, put the condenser into manual control before proceeding.
 - φ To make the speed at which the test occurs faster it is recommended to ensure both SJAEs are at 100% setpoint, making sure one of them is disabled before proceeding.
 - φ Once this is all completed you should record the settled pressure of the condenser then switch SJAEs and wait for that one to settle. If one of the SJAEs reads a higher pressure than the other by more than ~0.5mb it is likely malfunctioning.
 - φ It should also be noted that there is a small chance that both SJAEs can be equally broken and a malfunction in them cannot be detected. However, this is rare.
- Example:** The reactor and turbine pressure is stable, the condenser automatic control off, both SJAEs set to 100% with say SJAE 1 disabled and SJAE 2 enabled and reading a settled pressure of ~57.4mb. Then, with SJAE 2 disabled and SJAE 1 enabled, wait for the pressure to settle out. It then reads ~56.7mb. Here, SJAE 2 is likely malfunctioning due to the settled pressure being ~0.7mb higher than SJAE 1.
- Solution:** Disable the malfunctioning steam jet air ejector and mark it. There is no need to lower the setpoint.

Condenser Circulation Pump Malfunction

- Details:** The condenser circulation pumps are the primary system in attaining a vacuum in the condenser. Due to this, a malfunction in one or both condenser circulation pumps could cause the vacuum in the condenser to potentially be lost.
- Identification:**
- ϕ Testing for a condenser circulation malfunction will limit the condenser circulation flow at or less than 2500kg/s in U1, or 17.5t/s in U2. This may result in the loss of condenser vacuum at high powers. Therefore, it is advised that reactor thermal power be lowered to ~60% APR.
 - ϕ A malfunction in a condenser circulation pump only limits the maximum flow it can achieve, it does not affect the amount each % of setpoint gives or takes to the pump's flow. In other words, an individual pump will always output 50kg/s or 0.35t/s (U1/U2 respectively), or half of that if both pumps are enabled, for every % of setpoint; regardless of a pump's condition. Therefore, before proceeding you must have the setpoint at or above 50% to test if a pump can reach its maximum rated flow. (2500kg/s in U1, 17.5t/s in U2)
 - ϕ Additionally, you can temporarily enable both SJAEs to offset any drop in vacuum. This is mainly useful in U2 where pump lag is present. Furthermore, in U2 you can also disable both pumps to quickly reduce the flow rate to 17.5t/s, which once reached, a pump is enabled to test it.
- Example:**
- U1:
The reactor power is at ~60% APR with the condenser circulation pumps running at 50%. Pump 1 is disabled and pump 2 is enabled and reading ~2500kg/s of flow, pump 2 is healthy since 2500kg/s of flow is the maximum flowrate for a single pump. Pump 2 is disabled and pump 1 is enabled and now reads ~1970kg/s of flow. Pump 1 is broken since it is not moving the expected 2500kg/s of water.
- U2:
The reactor power is at ~60% APR with the condenser circulation pumps running at 50%. Pump 1 is disabled and pump 2 is enabled and reading ~17.5t/s of flow, pump 2 is healthy since 17.5t/s of flow is the maximum flowrate for a single pump. Pump 2 is disabled and pump 1 is enabled and now reads ~15.8t/s of flow. Pump 1 is broken since it is not moving the expected 17.5t/s of water.
- Solution:** Ensure reactor power is low enough so that just one condenser circulation pump can keep up with the steam generation rate, then disable the malfunctioning pump and mark it.

Main Cooling Circuit Panel

Feedwater Pump Malfunction

Details:

The feedwater pumps (FWP) are vital to keeping the reactor and the contents of it from melting down. Due to this, a malfunction in one or both feedwater pumps could cause the possible meltdown of the reactor.

Identification:

- φ The output for each of the feedwater pumps is linear in that for every ~1% of setpoint the pump will output ~10kg/s of flow.
- φ The formula [SETPOINT%]*10 will give the expected outflow of a single enabled pump.

U1:

- φ Since in U1 there is only one reading for both pumps it is required to bring reactor power below at least 60% APR for testing.

U2:

- φ In U2 there are two gauges making it much easier to see if a pump is malfunctioning since you don't have to change the power at all to diagnose.

Example:

U1:

The reactor power is below 60% APR for safety with only FWP 1 enabled at ~68% setpoint and reading out 680kg/s of flow because 68*10 equals ~680kg/s. FWP 1 is gradually reduced to 0% as FWP 2 is enabled and gradually brought up to ~68% setpoint and it reads out 530kg/s of flow. Here, FWP 2 is clearly malfunctioning because 68*10 does not equal 530kg/s.

U2:

FWP 1 is at a setpoint of ~59%, then it should be at 59*10 which will equal ~590kg/s. If it is otherwise not at 590kg/s, then it is likely malfunctioning. Vice versa for FWP 2.

Solution:

Ensure reactor power is low enough so that just one feedwater pump can keep up with the steam being generated, disable the malfunctioning feedwater pump and mark it.

Expected output value at certain setpoints:

1% setpoint	10kg/s outflow
5% setpoint	50kg/s outflow
10% setpoint	100kg/s outflow
25% setpoint	250kg/s outflow
50% setpoint	500kg/s outflow
100% setpoint	1000kg/s outflow

Condensate Pump Malfunction

Details:	The condensate pumps are important for ensuring water is moved from the hotwell into the deaerator to be deaerated and sent back into the reactor. If there is a malfunction, it could make keeping the flows between the three cooling circuit sections balanced more tedious.
Identification:	<ul style="list-style-type: none"> ϕ Be advised that testing the condensate pumps for malfunctions will limit the hotwell outflow rate at or below 1000kg/s temporarily. It is advised that reactor thermal power be lowered to ~60% APR. ϕ A malfunction in a condensate pump only limits the maximum flow it can achieve, it does not affect the amount each % of setpoint gives or takes to the pump's flow. In other words, an individual pump will always output 10 kg/s, or half that if both pumps are enabled, for every % of setpoint; regardless of a pump's condition. Therefore, before proceeding you must have the setpoint at or above 50% to test if a pump can reach its maximum rated flow. (which is 1000 kg/s)
Example:	The reactor power is at ~60% APR with condensate pump 1 running at 50% moving ~1000kg/s of outflow. Pump 1 is disabled and pump 2 is enabled, and it now reads ~810kg/s of flow at the same setpoint. Here, pump 1 is healthy since the maximum flow rate of one condensate pump is 1000kg/s and pump 2 is malfunctioning since it is not 1000kg/s of flow.
Solution:	Ensure reactor power is low enough so that just one condensate pump can keep up with the steam being generated and feedwater being demanded. Disable the malfunctioning condensate pump and mark it.

Preheater Malfunction

Details:	The preheaters are used to increase the efficiency of steam generation. Therefore, a malfunction of one or more of these can greatly decrease steam production and throw off other various plant processes.
Identification:	<ul style="list-style-type: none"> ϕ Testing for preheater malfunctions is relatively easy and quick. ϕ To test for malfunctioning preheaters ensure the reactor is operating nominally. Then, as you go along disable a singular preheater and observe the new water temperature before reenabling it and disabling the next preheater and so on. ϕ With the reactor operating normally and two of the three preheaters enabled the water temperature should be recording ~197°C if the two enabled preheaters are both working properly. If not, then one or more of the enabled preheaters are bad.
Example:	Disable preheater 1 and the total reading is 197°C, reenable preheater 1 and disable preheater 2 and it reads 194°C, reenable preheater 2 and disable preheater 3 and it reads 194°C. In this scenario, preheater 1 is broken because when it was disabled the water temperature was normal at 197°C, but the other tests with preheater 1 enabled never read nominally and therefore it is broken.
Solution:	Disable any malfunctioning preheaters and mark them.

Leak After Hotwell

Details:	The hotwell is where steam that has just gone through the turbine is condensed and ends up to be pumped away as liquid water to the deaerator.
Identification:	<ul style="list-style-type: none"> ϕ Identifying a leak after the hotwell is easy as long as the main cooling circuit flows are mostly balanced and no drain pumps are active. ϕ To identify a leak, watch the water level of the deaerator, if the flows are balanced properly and the water level is dropping at a steady rate (i.e. ~0.4m per minute), it is likely a leak. ϕ You can also go to the back of the condenser hall under where the deaerator for the unit is, any puddles of water present can be used as well to indicate a hotwell leak.
Example:	If all the flows are balanced properly at 1376kg/s on the main cooling circuit panel and the deaerator water level is dropping at ~0.4m per minute, a leak after the hotwell is present.
Solution:	<p>You can keep running with a leak active, but you will need to utilize the hotwell makeup pump and eventually the CST makeup pump(s) along with the condenser pumps at a higher setpoint to offset the lost flow.</p> <p>If you don't want to do the above, then safely shut the reactor down. It is advised to not scram the reactor due to the possibility of the scram causing a loss of coolant in the reactor especially at higher power levels and the possibility of a meltdown due to site usage being above the maximum load of the startup transformer.</p>

Leak After Deaerator

Details:	The deaerator is where water that has just been condensed in the hotwell/condenser has the air removed from it to prevent the corrosion of the reactor vessel.
Identification:	<ul style="list-style-type: none"> ϕ Identifying a leak after the deaerator is easy as long as the main cooling circuit flows are mostly balanced and no drain pumps are active. ϕ To identify a leak, watch the water level of the reactor. If the flows are balanced properly and the water level is dropping at a steady rate (i.e. ~0.4m per minute), it's likely a leak.
Example:	If all the flows are balanced properly at 1247kg/s on the main cooling circuit panel and the reactor water level is dropping at ~0.4m per minute, a leak is present.
Solution:	<p>You can keep running with a leak active, but you will need to utilize hotwell makeup pumps and eventually CST makeup.</p> <p>If you don't want to do the above, then safely shut the reactor down. It is advised to not scram the reactor due to the possibility of the scram causing a loss of coolant in the reactor especially at higher power levels and the possibility of a meltdown due to site usage being above the maximum load of the startup transformer.</p>

U2 Turbine Control Room

Turbine Hydraulic Oil Leak

- Details:** The turbine hydraulic oil is key to making sure the bearings and other moving parts in the turbine stay lubricated, preventing them from becoming damaged. Because of this, a hydraulic oil leak can jeopardize the operations of the U2 turbine.
- Identification:** φ There are a few ways to identify a hydraulic oil leak, but the primary way to detect a leak is if you have to close the backflow valve below ~65% to maintain ~12 bar of hydraulic oil pressure.
- Example:** If you are operating the U2 turbine and you have the backflow valve closed to ~66% to maintain the proper oil pressure of 12 bar, you have a hydraulic oil leak.
- Solution:** Notify U2 as soon as possible that the turbine needs to be run down for repairs, as if the oil leak gets out of hand it can cause an unplanned automatic trip of the turbine.

Dirty Turbine Oil Filter

- Details:** The turbine oil filter is vital to keeping the oil clean as it moves through the turbine to keep it cool and lubricated. Due to this, the oil filter becoming dirty can cause unexpected turbines trip due to not enough oil moving through the filter.
- Identification:** φ Utilize the provided meter attached to the filter assembly. You can compare filter status by clicking the blue bar with the black handle to switch filters, it should be noted that whatever side the bar is towards is the filter currently in use.
- Example:** During routine checks of the U2 turbine, it is discovered that the currently active filter (in this example it is the right filter or filter two) is nearing the yellow zone. In this case, it needs to be switched and replaced to prevent an inadvertent turbine trip from a dirty active filter.
- Solution:** If the other oil filter is still good then switch to that filter and replace the dirty filter as soon as possible by clicking the blue cover of the bad filter while the bar is on the side of the good filter. When the filter moves upward, click the core of it and you should collect it. Throw this item away in a dumpster in the special waste room under TCR by clicking the dumpsters with the bad filter enabled. Grab a new filter and click where the old filter used to be in the filter assembly, then click the top black ring of the filter so it descends back into the filter assembly.