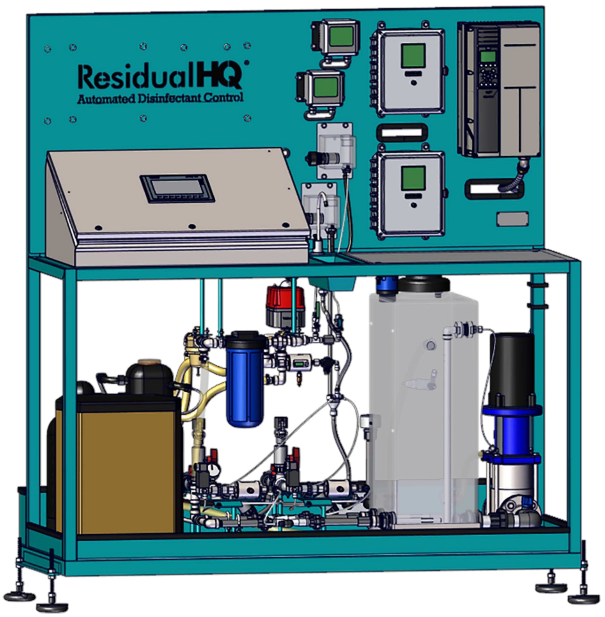
IXOM WATERCARE

ResidualHQ

Control Manual



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Safety

IMPORTANT

YOU MUST COMPLETELY READ AND FULLY UNDERSTAND THESE INSTRUCTIONS BEFORE INSTALLING, OPERATING, OR SERVICING THIS UNIT.

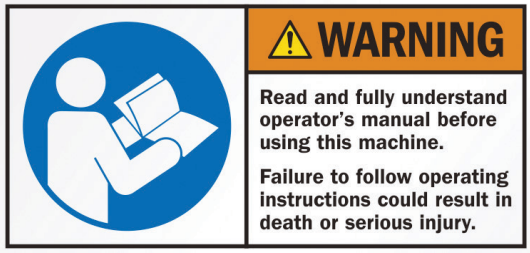
Be sure you have read all installation, operation, maintenance and safety instructions before you install, service or begin to operate this unit.

Accidents occur every year because of careless use of industrial equipment. You can avoid hazards by following these safety instructions, and applying some ordinary common sense when operating or servicing this unit.

Keep in mind that ***full operator attention and alertness*** are required when operating or servicing this unit.

USE COMMON SENSE!! Most accidents can be avoided by using ***common sense and concentration*** on the job being done.

Carefully read safety information when you see any safety symbols.



Safety

IMPORTANT

YOU MUST COMPLETELY READ AND FULLY UNDERSTAND THESE INSTRUCTIONS BEFORE INSTALLING, OPERATING, OR SERVICING THIS UNIT.

Identify all possible hazards. Determine what safeguards are needed and implement them. **Only you, the user,** understand your product and system characteristics fully. ***The ultimate responsibility for safety is with you. Your safety ultimately rests in your hands.*** Do your part and you will enjoy safe, trouble free operation for years to come. This instruction manual is not intended to include a comprehensive listing of all details for all procedures required for placement, operation and maintenance. If you have a question about a procedure or are uncertain about any detail, **Do Not Proceed.** Please contact GridBee Customer Service at **866-437-8076** to speak to a representative.

IMPORTANT!!!

Follow all federal and state laws in regards to safety regulations of working at heights, confined spaces, rescue, etc. as required by the U.S. Department of Labor, Occupational Safety and Health Administration. Use necessary PPE when placing and servicing this unit.

Electrical Hazard

WARNING: THIS EQUIPMENT CONTAINS HIGH VOLTAGE! ELECTRICAL SHOCK CAN CAUSE SERIOUS OR FATAL INJURY. ONLY QUALIFIED PERSONNEL SHOULD ATTEMPT PLACEMENT, OPERATION AND MAINTENANCE OF ELECTRICAL EQUIPMENT. REMOVE ALL SOURCES OF ELECTRICAL POWER BEFORE PERFORMING ANY SERVICE WORK TO THE MACHINE. USE PROPER LOCKOUT TAGOUT (LOTO) PROCEDURES TO ENSURE A SAFE WORK ENVIRONMENT.

Chemical Hazard

WARNING: HIGHLY FLAMMABLE LIQUID AND VAPOR. CAUSES MILD SKIN IRRITATION. CAN CAUSE SERIOUS EYE IRRITATION. KEEP AWAY FROM HEAT/SPARKS/OPEN FLAME. NO SMOKING. AVOID BREATHING VAPORS. USE IN WELL VENTILATED AREA. WEAR PROTECTIVE GLOVES. DO NOT EAT, DRINK OR SMOKE WHEN USING. WASH HANDS THOUROUGHLY AFTER HANDLING.

Rotating Hazard

CAUTION: KEEP BODY APPENANDAGES OR LOOSE CLOTHING AWAY FROM EQUIPMENT WHILE OPERATING. ENSURE EQUIPMENT IS OFF BEFORE ATTEMPTING SERVICE.

Laceration Hazard

CAUTION: EDGES MAY BE SHARP AND CAUSE LACERATION IF PROPER CARE IS NOT USED.

Entanglement Hazard

WARNING: ENSURE THAT PERSONNEL ARE CLEAR OF THE ELECTRIC CORD AND CHAIN TO AVOID ENTANGLEMENT.

Safety

Protect Yourself

It is important that you comply with all relative OSHA and local regulations while installing and performing any maintenance to the mixer circulation equipment.

Key OSHA Compliance Standards that must be followed (and not limited to) are:

- **1910.146 Permit-required confined spaces**
- **1910.147 Lockout/Tagout**
- **1926.500 Fall Protection**

Fall Protection Tips

- Identify all potential tripping and fall hazards before work starts.
- Look for fall hazards such as unprotected floor openings/edges, shafts, open hatches, stairwells, and roof openings/edges.
- Inspect fall protection and rescue equipment for defects before use.
- Select, wear, and use fall protection and rescue equipment appropriate for the task.
- Secure and stabilize all ladders before climbing.
- Never stand on the top rung/step of a ladder.
- Use handrails when you go up or down stairs.
- Practice good housekeeping. Keep cords, welding leads and air hoses out of walkways or adjacent work areas.

Refer to 29 CFR 1926.500 for complete regulations set by OSHA. Refer to your state's regulations if your state established and operates their own safety and health programs approved by OSHA.

Lockout Tagout

When the On/Off switch is in the "ON" position, the mixer may start up at any time if not already operating. The mixer's On/Off switch can be locked out by placing a pad lock thru the door latch of the controller after the switch has been turned to the "OFF" position. The On/Off switch is to be used as the emergency stop.

Permit-Required Confined Spaces

A confined space has limited openings for entry or exit, is large enough for entering and working, and is not designed for continuous worker occupancy. Confined spaces include underground reservoirs, ground storage tanks, elevated tanks, silos, manholes, and pipelines.

Confined Space Tips

- Do not enter permit-required confined spaces without being trained and without having a permit to enter.
- Review, understand and follow employer's procedures before entering permit-required confined spaces and know how and when to exit.
- Before entry, identify any physical hazards.
- Before and during entry, test and monitor for oxygen content, flammability, toxicity or explosive hazards as necessary.
- Use fall protection, rescue, air monitoring, ventilation, lighting and communication equipment according to entry procedures.
- Maintain contact at all times with a trained attendant either visually, via phone, or by two-way radio. This monitoring system enables the attendant and entry supervisor to order you to evacuate and to alert appropriately trained rescue personnel to rescue entrants when needed.

Refer to 29 CFR 1910.146 for complete regulations set by OSHA. Refer to your state's regulations if your state established and operates their own safety and health programs approved by OSHA.

Getting Started

Navigation, Layout, and Basic Configuration

Navigation

Menus are traversed via touchscreen, or pushbuttons. When graphical buttons are shown directly above tactile pushbuttons, the two functions are identical. This is shown in Figure 1, with subsequent traversal to the next screen in Figure 2.

Figure 1: Welcome screen

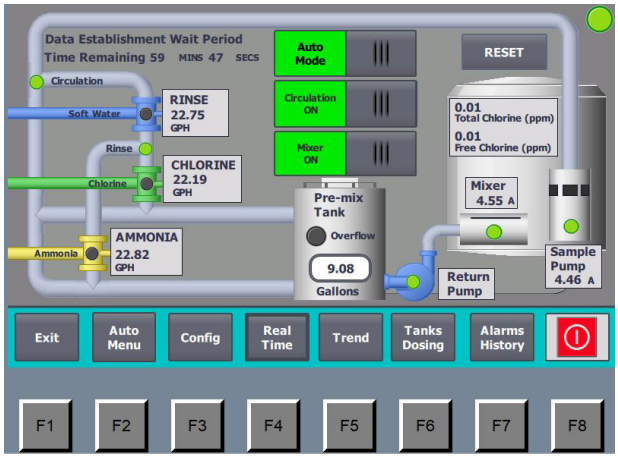


Figure 2: Next screen, no authorization

Access Protection

The graphic highlighted in Figure 2 is utilized throughout the control program to log-in and access protected functions. The system utilizes an authorization hierarchy to prevent unwanted tampering or control. Users are granted permissions by a System Administrator, which may be maintained locally to manage user profiles. When the icon is selected, a log-in dialogue is initiated as shown in Figures 3 and 4.

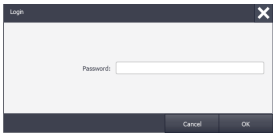


Figure 3: Login

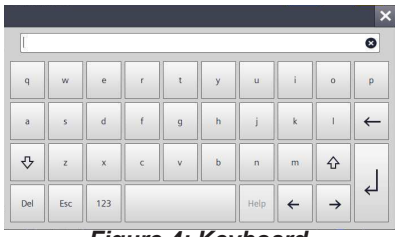


Figure 4: Keyboard

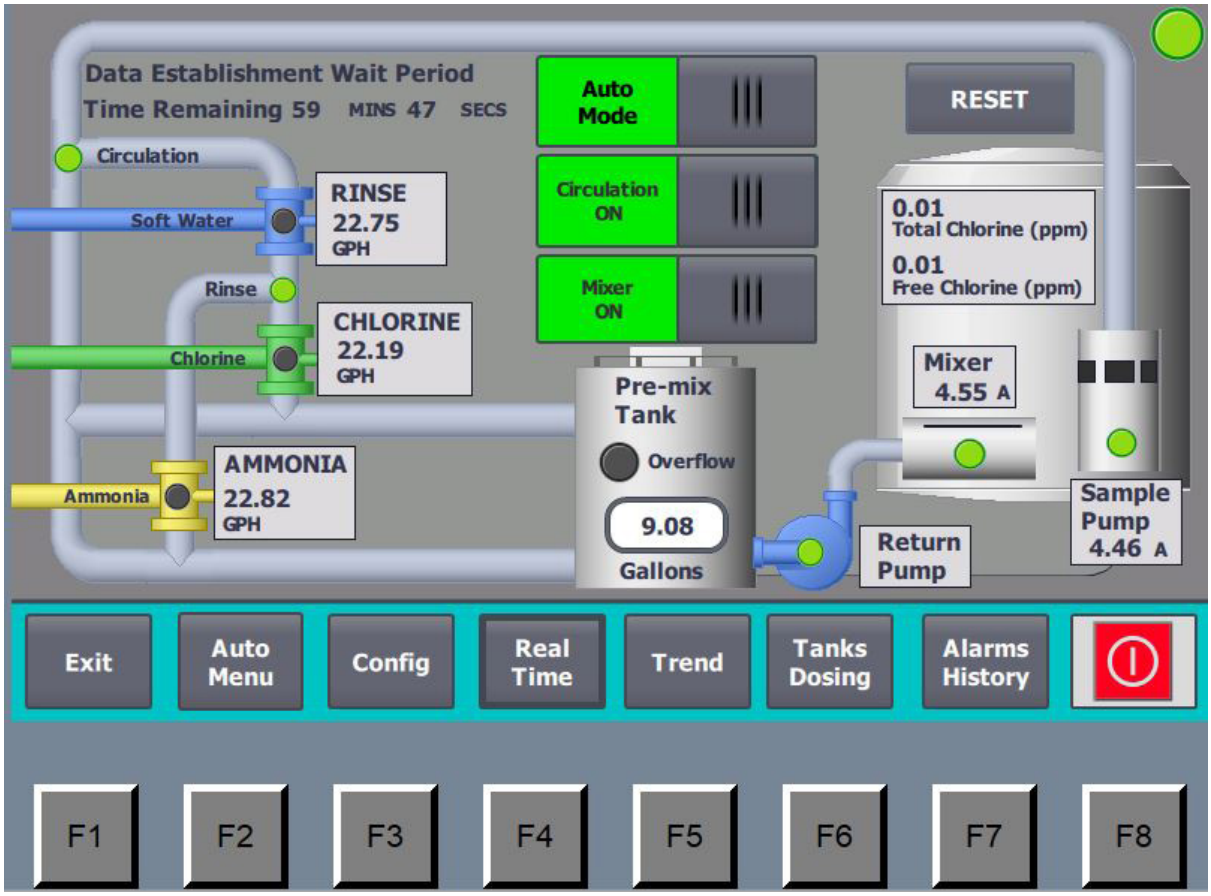
Authorizations

When a user is recognized, the system will grant the appropriate access, allowing the user to perform differing ranges of functions within the system.

1. Monitors
2. Operators
3. Configurators
4. Administrators (Full)

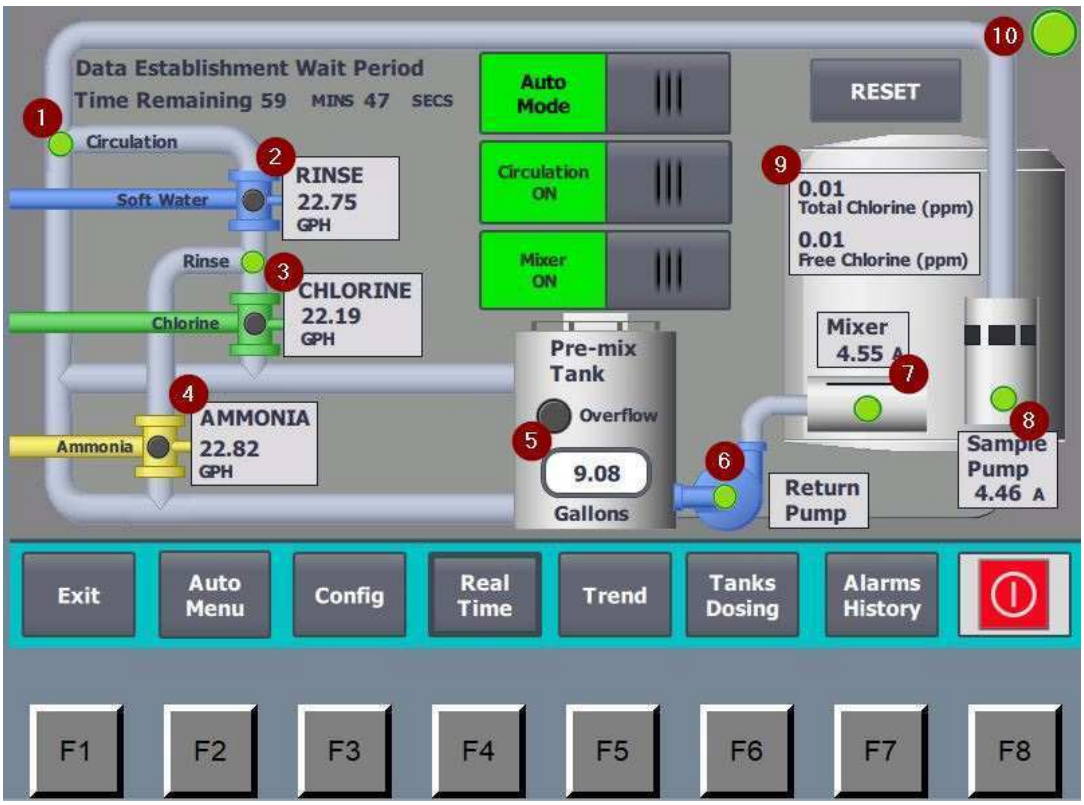
New Control Menu

1 Main Menu Controls



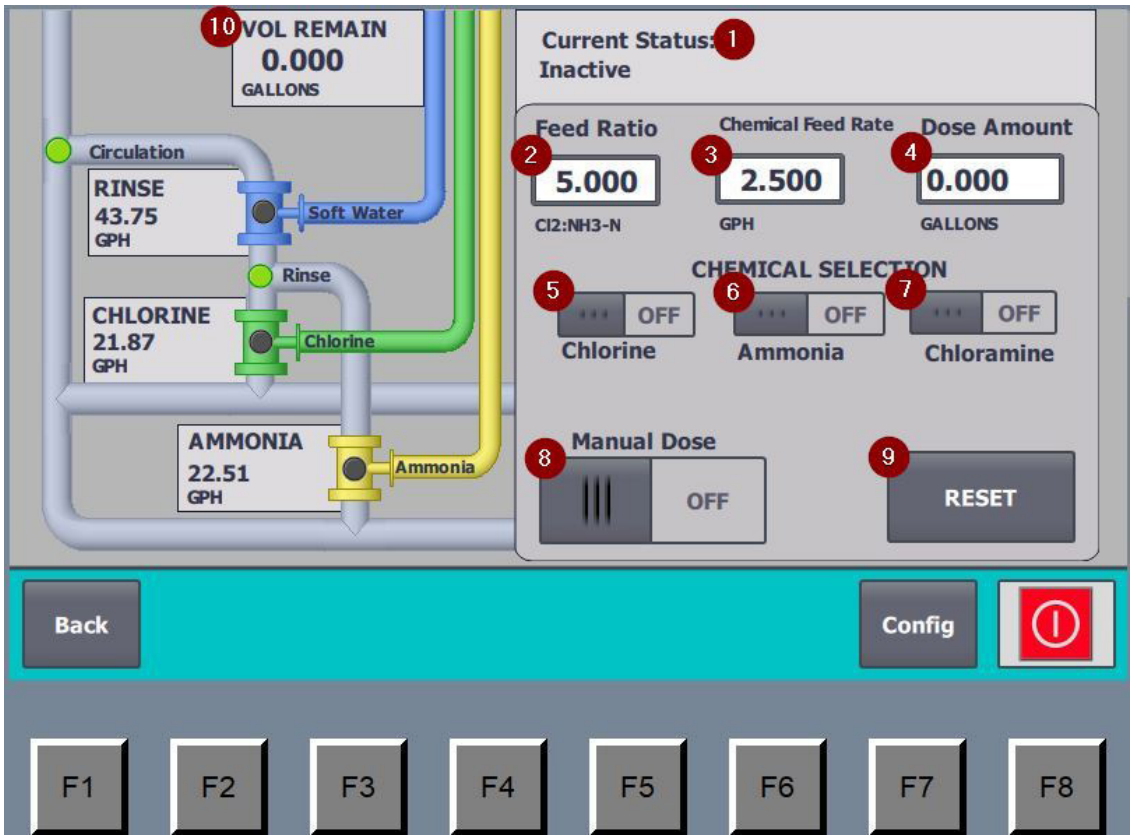
1. AUTO/MANUAL MODE - Switch to toggle between automated dosing and manual dosing
2. CIRCULATION ON/OFF - Switch to toggle on/off the circulation pumps. Turning CIRCULATION ON requires that the SAMPLE PUMP and RETURN PUMP VFD are set to AUTO
3. MIXER ON/OFF – Switch to toggle on/off mixer. Mixer must be set to AUTO
4. RESET – Reset mode and clears active alarms
5. EXIT – Go to WELCOME screen
6. AUTO MENU – Go to auto settings screen
7. CONFIG – Go to configuration menu
8. REAL TIME – Go to main control screen
9. TREND – Go to Trend screen
10. TANKS DOSING – Go to tank and dosing info screen
11. ALARM HISTORY – Go to alarm history screen
12. SHUTDOWN – Stop circulation and dosing of the machine

2 Main Menu Readings



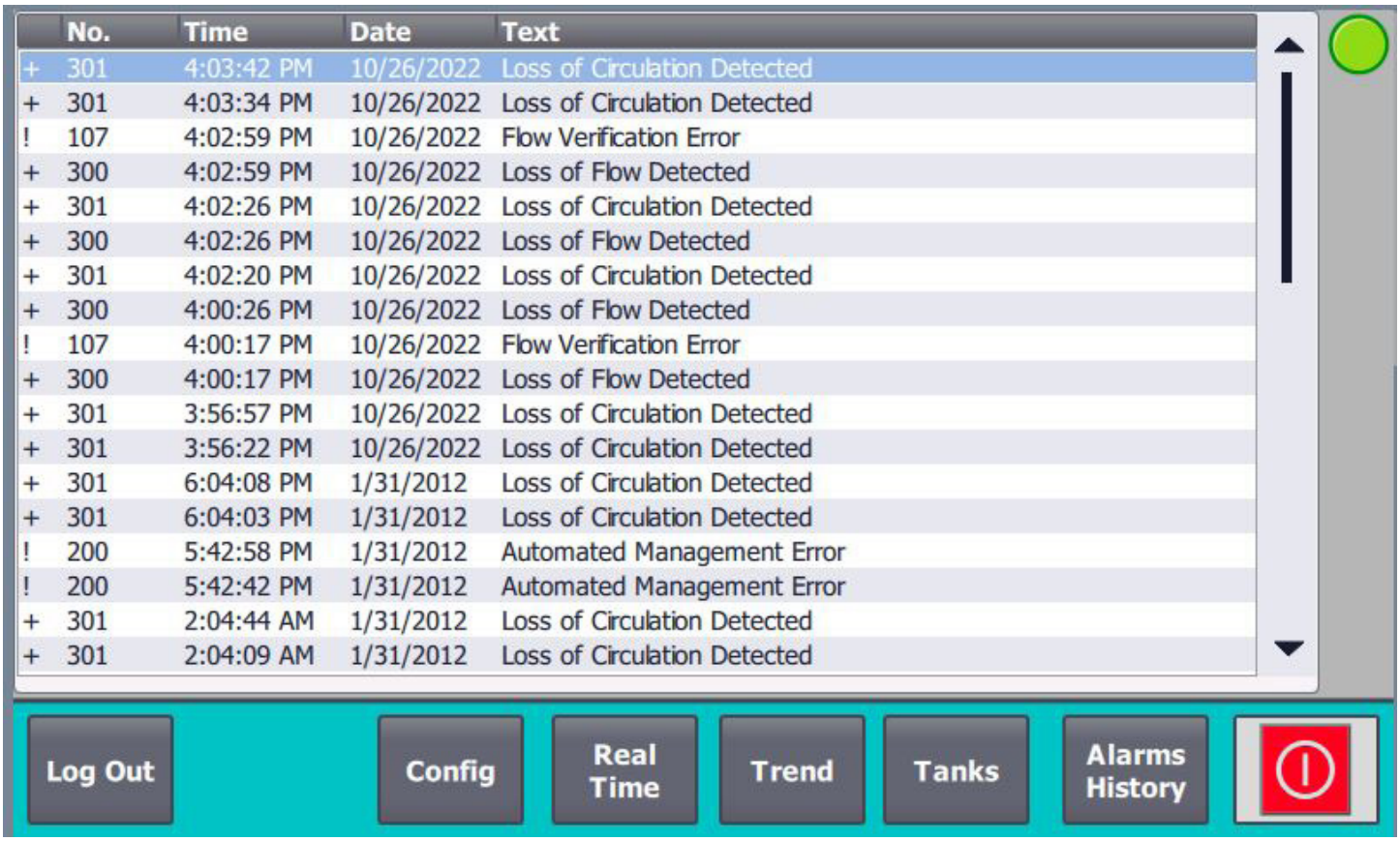
1. CIRCULATION STATUS – Status indicator for circulation
2. RINSE STATUS – Soft water valve indicator illuminates when open. Rinse flow meter value is displayed in box
3. CHLORINE – Chlorine valve indicator illuminates when open. Chlorine flow meter value is displayed in box
4. AMMONIA – Ammonia valve indicator illuminates when open. Ammonia flow meter value is displayed in box
5. PREMIX TANK – Overflow status indicator illuminates red when take is at or above 14 gallons. Current fill level is also displayed
6. RETURN PUMP – return pump status indicator illuminates when pump in running
7. MIXER – Amperage is displayed in the box. Status indicator LED lights illuminates if Mixer is operational.
8. SAMPLE PUMP - Amperage is displayed in the box. Status indicator LED lights illuminates if sample pump is operational.
9. TOTAL CHLORINE & FREE CHLORINE values are displayed in box in ppm
10. SYSTEM STATUS – indicator illuminates red when in system fault

3 Manual Dose Controls



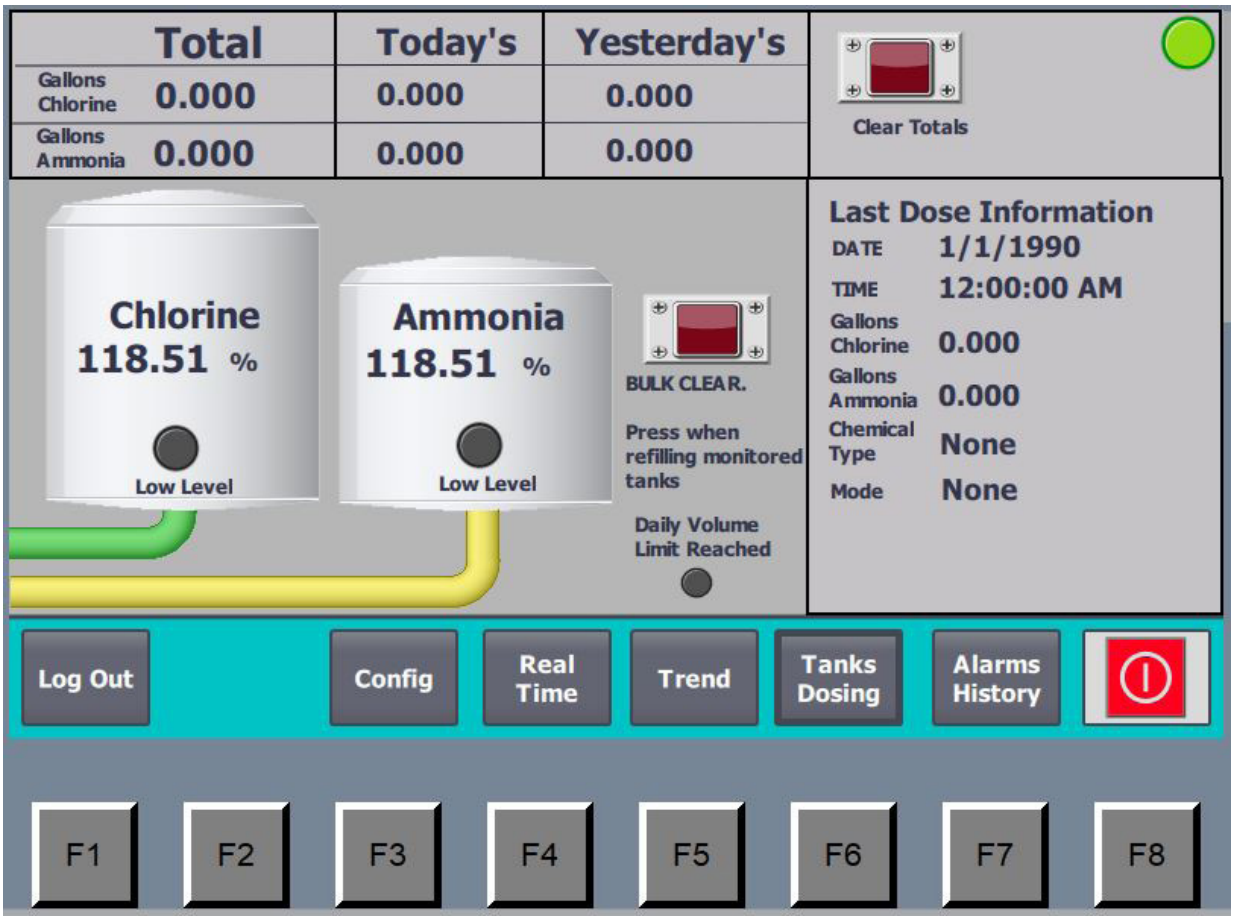
1. Mode status – description of the operating mode
2. Chlorine to ammonia mass feed ratio
3. Chemical feed rate
4. Dose amount
5. Chlorine only dose select
6. Ammonia only dose select
7. Chloramine dose select
8. Start manual dose
9. Reset alarms

4 Alarms



Alarm Number – identifier for each alarm
Time – Time of day at which alarm occurred
Date – Day, month, and year at which alarm occurred
Text – Description of Alarm

5 Tanks and Dosing Information



Total gallons of chemical are displayed for overall, today, and yesterday. Today's total chemical use will roll over to yesterdays after the set time of day.

If chlorine and ammonia bulk chemical tanks are connected with level sensors their levels will be displayed respectively.

When refilling chemical in monitored bulk tanks, be sure to press the "BULK CLEAR" button otherwise the system will error out.

6 Trendline

Trendline data will populate based on setting set in TRENDING AND HISTORICAL CONFIGURATION. The toolbar at the bottom of the graph can be used for navigating to points of interest.

Configuration Menu

Parameter Information

Overview

Users with Configuration permissions will have access to the following screens and menus. These menus should be accessed with caution, as many settings will directly change the operation of the system in automated modes, resulting in changes to automated decision-making processes and actions.

Base ► Configure ► System

Name	Units	Def.	Low	High	Description
Motor Current Limit	%	10	0	100	Motor over/under current limit (Sample Pump and Mixer monitor)
Sample Current Setpoint	amps	12.00	0.00	20.00	Sample Pump typical operating current setpoint
Mixer Current Setpoint	amps	12.00	0.00	20.00	Mixer typical operating current setpoint
Chlorine Degas Enable	T/F	T			Enable chlorine degassing scheme
Ammonia Degas Enable	T/F	F			Enable ammonia degassing scheme
Remote Enable	T/F	F			Enable remote control (Via Modbus RTU)
Modbus ID		1	1	256	Low level alert for bulk chlorine storage. Units and Low/High limits user-defined.
Modbus Reload	T/F	F			Modbus RTU reload request. Required after Modbus ID change.
Screen Timeout	secs	300	0	9999	Seconds of inactivity before automatic logout
Local Log Start	T/F	F			Start/restart local (HMI USB) datalogging
Local Log Stop	T/F	F			Stop local (HMI USB) datalogging
Set System Time					Set system (local) time. Enter value, press button to save
Fatal Fault Definition	T/F	F			Stops sample if: Ammonia valve routine error
Fatal Fault cont'd	T/F	F			Stops sample if: Chlorine valve routine error
Fatal Fault cont'd	T/F	F			Stops sample if: Chemical feed routine error
Fatal Fault cont'd	T/F	F			Stops sample if: Mixer monitoring routine error
Fatal Fault cont'd	T/F	F			Stops sample if: Unaccounted bulk chemical change
Fatal Fault cont'd	T/F	F			Stops sample if: Flow verification failure
Fatal Fault cont'd	T/F	F			Stops sample if: Degassing routine error
Fatal Fault cont'd	T/F	F			Total Chlorine readings out of range
K Factor Rinse		3785.41			K factor value for Rinse flow meter
K Factor Chlorine		3785.41			K factor value for chlorine flow meter
K factor ammonia		3785.41			K factor value for chlorine flow meter
Retry attempts		8			Circulation retry attempts after a nonfatal error has occurred
Sleep Timer	Minutes	10			Minutes system can be powered down before turning off circulation on reboot
Total Chlorine Max.	ppm	4.0			Alarm if total chlorine is above this value
Total Chlorine Min.	ppm	0.5			Alarm if total chlorine is below this value
Remote Tank input	T/F	F			Use customer input for tank data over modbus

Configuration Menu

Parameter Information

Base ► Configure ► General Operation

Name	Units	Def.	Low	High	Description
Flow Rate	GPH	1.00	0.00	2.50	Flow rate of the set/commanded chemical. Common setting for automated and manual actions.
Feed Ratio		4.00	0.000	5.000	Ratio of Cl_2:NH_3-N. Common setting for automated and manual actions.
Ratio Factor		1.63	0.000	10.00	Ratio of (Wt. NaClO (lbs/G) * % Avail. Cl_2):(Wt. LAS (lbs/G) * % Avail. N). Common setting for automated and manual actions.
Chlorine Flow Adj.		0.800	0.000	9.999	Calibration adjustment factor [Flow = Adjust * Sensor]
Ammonia Flow Adj.		0.800	0.000	9.999	Calibration adjustment factor [Flow = Adjust * Sensor]
Actuation Change %	%	50.00	0.00	99.99	Minimum recognition percentage of recent valve actuations
Flow Error %	%	25.00	0.00	99.99	Maximum allows deviation from expected flow sum

Base ► Configure ► Automated Management

Name	Units	Def.	Low	High	Description
Data Establishment Duration	mins	30	0	32767	Length of time system waits for trending data to stabilize prior to action [Automated Management Mode decisions]
Action Timeout	mins	1440	0	32767	If last dose was not made within this timeout duration, prior actions will not be considered [Automated Management Mode decisions]
Feed Duration	mins	4	0	32767	Feed duration before stopping to wait and see effect [Automated Management Mode decisions]
Determination Time	mins	60	0	32767	Duration of wait period after feed has been stopped before making trend or threshold determinations [Automated Management Mode decisions]
Determination Hysteresis	mins	5	*	*	Number of minutes system waits before checking if threshold crossing was false positive. Setting must be greater than the Trending Data Register Period, and less than Confirmation Wait.
Residual Target	ppm	3.00	0.00	20.00	Desired chlorine residual level. System will attempt to maintain this level while in Automated Management Mode.
Crossover Target	ppm	3.00	0.00	20.00	Chlorine residual level at which the system will change from chlorine to chloramine during recovery to avoid overshoot and subsequent residual destruction [Automated Management Mode]
Decrease Threshold	ppm	1.00	0.00	*	When residual drops below this point system will take action [Automated Management Mode]. Setting must be less than Residual Setpoint
Recovery Threshold	ppm	0.25	0.00	*	When residual increases above this point system will consider setpoint reached [Automated Management Mode]. Setting must be less than Decrease Threshold.
Recovery Attempt Limit		2	0	32767	Number of attempts system will make to recognize a residual increase during recovery [Automated Management Mode]
Breakpoint Ratio		0.45	0.00	1.00	Ratio of Free Chlorine to Total Chlorine that triggers Breakpoint Detection [Automated Management Mode]

Configuration Menu

Parameter Information

Base ► Configure ► Trending and Historical Data

Name	Units	Def.	Low	High	Description
Trending Data Register Period	mins	1	0	32767	Minutes between logging of trending data values
Residual Trend Points		5	0	32767	Number of data points averaged for “recent” data
Chlorine Vol. Limit	gals	12.0	000.0	330.0	Feed volume limit (24 hour period)
Ammonia Vol. Limit	gals	12.0	000.0	330.0	Feed volume limit (24 hour period)
Unaccounted Change Limit	%	10.00	0.00	100.0	Unaccounted change monitor. If the bulk storage sensor reports an unaccounted change (no dosing/reset for fill) in the set period the system will report an error.
Unaccounted Change Timeout	hrs	15	0	24	Unaccounted change monitor. If the bulk storage sensor reports a change greater than the limit during this time period, the system report an error.
Low Level Chlorine	?	15	*	*	Low level alert for bulk chlorine storage. Units and Low/High limits user-defined.
Low Level Ammonia	?	15	*	*	Low level alert for bulk chlorine storage. Units and Low/High limits user-defined.
Low Level Monitor Tank	?	15	*	*	Low level alert for monitored tank. Units and Low/High limits user-defined.
Tank Sensor Units		‘%’			User-defined String for Tank Sensor Units. Max of 4 characters.
Tank Sensor Min.	?	0.0	(-)	(+)	User-defined Floating point low limit for Tank Sensor. Used to scale input value (linear).
Tank Sensor Max.		100.0	(-)	(+)	User-defined Floating point high limit for Tank Sensor. Used to scale input value (linear).
Bulk Chlorine Units		‘%’			User-defined String for Bulk Chlorine Storage Units. Max of 4 characters.
Bulk Chlorine Min.	?	0.0	(-)	(+)	User-defined Floating point low limit for Bulk Chlorine Storage. Used to scale input value (linear).
Bulk Chlorine Max.		100.0	(-)	(+)	User-defined Floating point high limit for Bulk Chlorine Storage. Used to scale input value (linear).
Bulk Ammonia Units		‘%’			User-defined String for Bulk Ammonia Storage Units. Max of 4 characters.
Bulk Ammonia Min.	?	0.0	(-)	(+)	User-defined Floating point low limit for Bulk Ammonia Storage. Used to scale input value (linear).
Bulk Ammonia Max.		100.0	(-)	(+)	User-defined Floating point high limit for Bulk Ammonia Storage. Used to scale input value (linear).

Initial Settings

Overview

The ResidualHQ system has a profound impact on the operation of a tank requiring a systematic tuning process that provides the best opportunity for sustained disinfectant residual management. Many factors may impact operational settings, such as initial disinfectant levels and ratios, water age, tank piping, turnover and usage, fill rates, and temperature. While not required during routine start-up operations, the following steps should be taken upon initial placement of the equipment.

Step 1 – Begin Sampling

Prior to the addition of chemical to the tank, or even mixing, the ResidualHQ should be given time to sample the water for a suggested duration of one hour. During this time the online analyzers are given time to stabilize, and should then be calibrated, by manually measuring Total and Free Chlorine residuals. In the case of chloraminated systems, Monochloramine and Free Ammonia tests are also beneficial for more advanced tuning.

Step 2 – Begin Mixing

Once initial residual tests are concluded, the mixer(s) should be turned “ON”. The addition of an active mixer will likely cause a temporary increase in chlorine demand, resulting in a residual decrease within the monitored tank. While not always possible the mixer should be allowed to operate for 24 hours in order for chlorine demand to stabilize.

Step 3 - Begin Corrections

The system is loaded with default settings for Automated Management. However, at a minimum the following settings should be confirmed prior to starting operation at a specific tank location:

- Residual Target: Desired chlorine residual level
- Decrease Threshold: Decrease in residual prior to action
- Feed Rate: Rate at which disinfectant is fed
- Feed Duration: Duration disinfectant is fed during correction
- Determination Wait Time: Length of time after the conclusion of disinfectant feed prior to analyzing result

The following pages should only be used as a guideline, and should not completely replace prior knowledge or operating procedures, and is not intended to supersede any existing statutes or laws. A spreadsheet is available that follows the calculations detailed below and the example found in Appendix A. Please contact Ixom Watercare, Inc. Customer Service for more information.

Step 3.A – Chemical Calculations

In order to calculate required amounts of disinfectants, the strengths of the respective disinfectants used must be known.

- Pounds of Available Chlorine Per Gallon (G)

$$Disinfectant\ Weight, \frac{lbs\ X}{G} = \frac{(Available\ Disinfectant, \%)(Specific\ Gravity, S.G.)\left(8.34\ \frac{lbs\ H_2O}{G}\right)}{100} \quad (1)$$

- Ratio Factor of Chlorine-to-Ammonia
  - Used in chloraminated systems to determine application ratio

$$Ratio\ Factor, R.F. = \frac{(Available\ Chlorine, \%)(Chlorine\ Specific\ Gravity, S.G.)}{(Available\ Nitrogen, \%)(Ammonia\ Specific\ Gravity, S.G.)} \quad (2)$$

Initial Settings

Step 3.B – Correction Amount

In order to get baseline settings, the correction amount will be determined by the following parameters:
- Incoming Water Residual Concentrations
- Outgoing Water Residual Target
- Daily Usage or Flow (Millions of Gallons Per Day, MGD)
- Tank Volume or Size (Millions of Gallons, MG)

Since usage is generally cyclical over a 24-hour period, we define “low turnover” as daily flows less than the tank volume. Conversely, “high turnover” is daily flows exceeding the tank volume.

If the incoming water is generally at the Target Residual level, the Desired Increase (Eq. 3) should be equal to the residual loss that typically occurs in the tank. The system must have the capacity to increase all water by the Desired Increase (Eq. 3). Additional capacity is also recommended, as tank-specific factors such as usage variability, loss of residual, fill rates, etc. may impact chlorine demand. As a starting point, 30% additional capacity may be used for many applications.

$$Desired\ Increase, ppm = (Residual\ Target, ppm) - (Incoming\ Residual, ppm) \quad (3)$$

$$Daily\ Volume, \frac{G\ NaOCl}{day} = (1 + (Add'l\ Capacity, \%)) \frac{(Flow, MGD)(Desired\ Increase,\ ppm)\left(8.34\ \frac{lbs\ H_2O}{G}\right)}{Chlorine\ Weight, \frac{lbs\ Cl_2}{G}} \quad (4)$$

For initial settings, this daily volume should be distributed into 2-4 Corrections Per Day.
- If low turnover, or incoming water is generally “good” (close to or above target residual), less reactive dosing may be used (lower number of corrections)
- If high turnover and incoming water has low residual, more reactive dosing will be required (higher number of corrections)

	Low Turnover	***High Turnover***
Incoming Residual ≪ Target Residual	*3 Corrections Per Day*	*4 Corrections Per Day*
Incoming Residual ≅ Target Residual	*3 Corrections Per Day*	*2 Corrections Per Day*

$$Correction\ Volume, G\ NaOCl = \frac{Daily\ Volume, \frac{G\ NaOCl}{day}}{Corrections\ Per\ Day} \quad (5)$$

- At this point, a check should be made to ensure the incremental correction amount is deemed acceptable by the operator. If the amount is too high, increase the number of corrections to lower the incremental correction amount.

$$Resulting\ Increase, ppm = \frac{(Correction\ Volume, G\ NaOCl)\left(Chlorine\ Weight, \frac{lbs\ Cl_2}{G}\right)}{(Tank\ Fill, MG)\left(8.34\ \frac{lbs\ H_2O}{G}\right)} \quad (6)$$

Once an acceptable incremental volume is found, the Feed Rate and Feed Duration (Eq. 7) may be set. For standard units, a starting Feed Rate of 1.25 GPH may be used. This is approximately equal to 50% of the standard unit’s capacity, and allows flexibility in further tuning.

$$Feed\ Duration\ (Initial), mins = \frac{(Correction\ Volume, G\ NaOCl)(60)}{Feed\ Rate, GPH} \quad (7)$$

Initial Settings

Step 3.C – Determination Wait Time

The Determination Wait (Eq. 8) time is the length of the time the system waits after a corrective action to determine the outcome. Using values found in the previous step (3.B)

$$Determination\ Wait\ (Initial), mins = \frac{1440\ mins - (Corrections\ Per\ Day)(Feed\ Duration\ (Initial), mins)}{Corrections\ Per\ Day} \quad (8)$$

Step 3.D – Decrease Threshold

The Decrease Threshold (Eq. 9) is how far the system will let the monitored residual drop from the Target Residual setting prior to beginning disinfectant feeds. For an initial value, the Residual Increase (Eq. 6) value calculated above may be used along with a percentage of recovery.

- Chlorinated Recovery Percentage: 70-100%
  - In chlorinated systems larger corrections are acceptable since we do not have to worry about additional chemical reactions as in the case of chloraminated systems
- Chloraminated Recovery Percentage: 50-70%
  - Smaller increments are beneficial since the objective is to re-bind available ammonia without overshooting and negatively impacting the existing residual levels

	Low Turnover	***High Turnover***
Chlorinated System	70%	100%
Chloraminated System	50%	70%

$$Decrease\ Threshold, ppm = \frac{(Resulting\ Increase, ppm)(100)}{Recovery\ Percentage, \%} \quad (9)$$

Step 4 - Continued Tuning

Once the system has made several corrections the Determination Wait Time should be matched to the dynamic conditions of the tank, accounting for mixing, fill cycles, usages, etc. Adjustments should be made based on residual changes witnessed after each corrective action. For most applications, Determination Wait Time should equal the length of time until residuals have stabilized after the conclusion of a feed, with a minimum of 1 hour.

Since the Determination Wait Time will now be a known value based on operational conditions of the tank, it may be used to further tune the corrective settings of the unit. At this point, Daily Volume (Eq. 4) may be updated if conditions have changed. This will be used to determine an updated Feed Duration (Eq. 10) as a function of the matched Determination Wait Time, as well as an updated Decrease Threshold (Eq. 9).

$$Feed\ Duration\ (Det.Wait), mins = \frac{\left(Daily\ Volume, \frac{G\ NaOCl}{day}\right)(Determination\ Wait\ Time\ (Matched), mins)}{(24\ hrs)(Feed\ Rate, GPH) - \left(Daily\ Volume, \frac{G\ NaOCl}{day}\right)} \quad (10)$$

$$Resulting\ Increase, ppm = \frac{(Feed\ Rate, GPH)(Feed\ Duration\ (Det.Wait), mins)\left(Chlorine\ Weight, \frac{lbs}{G}\right)}{(Tank\ Fill, MG)\left(8.34\ \frac{lbs}{G}\right)(60\ mins)} \quad (11)$$

Initial Settings

Step 4 - Continued Tuning

$$Decrease\ Threshold, ppm = \frac{Resulting\ Increase, ppm}{Recovery\ Percentage, \%} \quad (9)$$

The resulting settings above can also be changed by altering the Additional Capacity (Step 3.B.) and Feed Rate, or by changing the Decrease Threshold (Eq. 9). However, during these adjustments the following must be kept in mind:

- Minimizing Determination Wait Time allows the system to be more responsive, keeping the incremental doses smaller
- Decrease Threshold does not necessarily need to be updated when the Feed Duration is updated, but doing so will help ensure the responses are made at appropriate levels

Additional Parameters

- Recovery Threshold
  - May be used to change recovery characteristics. System will stop corrections once within this amount from the residual target, making an “acceptable recovery”. This may be used to mitigate overshoot, or decrease sensitivity of the system. Default set at 0.1ppm, but may be adjusted based on witnessed results, feed rates used, and mixing turnover times.
- Crossover Target
  - In high-use situations where recovery time is limited a Crossover Target may be employed. Should be set at a residual level equal to or less than the boost potential of the incoming water, as determined by manual analysis of typical incoming free ammonia concentrations, or set below the point at which a “dip” or decrease in residual is typically witnessed during recovery.
- Determination Hysteresis
  - The length of time the system waits after crossing a threshold during recovery (Crossover Target, Residual Target) before checking for false positive.
- Confirmation Wait
  - During recovery to a target, the residual must remain above a threshold for at least this length of time to be considered valid. If the residual drops below the Recovery Threshold in the window, the system will resume previous corrective actions.

Initial Settings

Appendix A – Example Calculations

Example calculations are shown with the following parameters:

Sodium Hypochlorite Concentration (% Avail. Cl_2), %	12.5 % (12 % Avail. Cl_2)
Liquid Ammonium Sulfate Concentration (% Avail. N), %	35 % (7.35 % Avail. N)
Tank Avg. Fill (Millions of Gallons), MG	0.2 MG
Daily Usage (Millions of Gallons), MG	0.2 MG
Target Residual Concentration, ppm	3.5 ppm
Incoming Residual Concentration, ppm	1.3 ppm

Step 3.A

$$1.2\ \frac{lbs\ Cl_2}{G} = \frac{(12\ \%)(1.2\ S.G.)\left(8.34\ \frac{lbs}{G}\right)}{100} \quad (1)$$

$$1.63\ R.F. = \frac{(12\ \%)(1.2\ S.G.)}{(7.35\ \%)(1.2\ S.G.)} \quad (2)$$

Step 3.B

$$2.2\ ppm = (3.5\ ppm) - (1.3\ ppm) \quad (3)$$

$$3.98\ \frac{G\ NaOCl}{day} = (1.3)\frac{(0.2\ MGD)(2.2\ ppm)\left(8.34\ \frac{lbs}{G}\right)}{1.2\ \frac{lbs}{G}} \quad (4)$$

$$3.5\ ppm \gg 1.4\ ppm\ AND\ High\ Turnover, choose\ 4\ Corrections\ Per\ Day$$

$$0.72\ ppm = \frac{(1\ G\ NaOCl)\left(1.2\ \frac{lbs\ Cl_2}{G}\right)}{(0.2\ MG)\left(8.34\ \frac{lbs\ H_2O}{G}\right)} \quad (6)$$

$$48\ mins = \frac{(1\ G\ NaOCl)(60)}{1.25\ GPH} \quad (7)$$

Step 3.C

$$312\ mins = \frac{1440\ mins - (4)(48\ mins)}{4} \quad (8)$$

Step 3.D

$$Chloraminated\ System\ AND\ High\ Turnover, choose\ 70\%\ Recovery\ Percentage$$

$$1.03\ ppm = \frac{(0.72\ ppm)(100)}{70\ \%} \quad (9)$$

Step 4

$$No\ changes, so\ Daily\ Volume\ and\ Feed\ Rate\ remain\ the\ same\ (3.97\ G\ and\ 1.25\ GPH)$$

$$After\ several\ corrections, residuals\ typically\ stablized\ after\ approximately\ 200\ minutes$$

Initial Settings

Appendix A – Example Calculations cont'd

Step 4 cont'd

$$31\ mins = \frac{\left(3.97\ \frac{G\ NaOCl}{day}\right)(200\ mins)}{(24\ hrs)(1.25\ GPH) - \left(3.97\ \frac{G\ NaOCl}{day}\right)} \quad (10)$$

$$0.46\ ppm = \frac{(1.25\ GPH)(31\ mins)\left(1.2\ \frac{lbs}{G}\right)}{(0.2\ MG)\left(8.34\ \frac{lbs}{G}\right)(60\ mins)} \quad (11)$$

$$0.66\ ppm = \frac{(0.46\ ppm)(100)}{70\ \%} \quad (9)$$

Settings Summary

Residual Target, ppm	3.5 *ppm*
Decrease Threshold, ppm	0.66 *ppm*
Feed Rate, GPH	1.25 *GPH*
Feed Duration, mins	31 *mins*
Determination Wait Time, mins	200 *mins*

Modbus Communication

Interface and Diagnostics

Capabilities

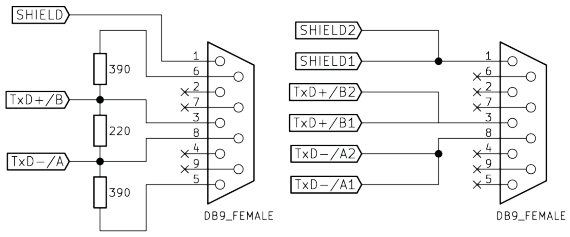
The ResidualHQ controller comes standard with Modbus RTU (RS-485) serial communication capabilities. The controller operates as a slave device, supporting the following function codes: Read Holding Registers (0x03), Write Single Holding Register (0x06), and Write Multiple Holding Registers (0x10). Read capabilities are always available, while Read/Write is access-protected and must be enabled locally in under *Configure* > *System* > *Remote Enable*. More information relating to the Modbus protocol and specification can be found at www.modbus.org.

Interface (DB9 female)

Pin	Description
1	Logic or communication ground
2	N/A
3	TxD+ (B)
4	N/A
5	Logic or communication ground
6	+5VDC (240mA max.)
7	N/A
8	TxD- (A)
9	N/A

Communication Parameters

Setting	Value
Baud Rate	19.2k (standard)
Bits/Byte	8
Parity	None
Stop Bits	1
Address Range (ID)	1-247



Left: Terminating device (bias ON)
Right: Non-terminating device (bias OFF)

Configuration

Modbus-specific parameters can be found locally at the HMI under *Configure* > *System.*

- If *Modbus RTU ID* (slave address) is changed, *Modbus RTU Reload* must be pressed to process the identification change.

Values provided are unsigned 16 bit integers, with values ranging from 0 to 65535. In order to represent floating point numbers (*ex. 2.95*) a scaling factor is used.

- Read values should be divided by the Scale given in the Modbus Parameter Tables (*ex. 295 / 100 = 2.95).*
- Likewise, written values should be multiplied by the Scale prior to sending the command (*ex. 2.95 * 100 = 295*).

In certain instances registers are reported as hexadecimal (denoted by 0x) values to represent status information. Additionally, certain registers indicate relevant information through bit positions.

- For example, a value of 0x0070 (decimal 112) represents a Standby status in several modes of operation.
- Similarly, Bit 3 may represent a valve position, or area-specific error recognized by the system.
- Boolean values are reported as 16 bit integers where: True == 0x0001 and False == 0x0000.

If an invalid or out-of-range write value is attempted, the command will be ignored and the register will retain the previous value.

Register-specific information may be found in the Modbus Parameter Tables.

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Setting Range		Mult.	Units	Description
System Operational Mode	1	R	0x00XX	Automated Management	1		System Operational Mode. Low byte mode-specific status. See mode specific registers for more information.
			0x10XX	Manual Dosing			
			0x30XX	Maintenance			
			0x60XX	Transition			
			0x8FXX	Error			
System OK	2	R	0		1		Overall system status. If set, the system is capable of feeding/dosing chemical.
			1				
Residual Range	3	R	0		1		Residual level is above target, or Automated Management Mode is actively working to increase residual level.
			1				
Warning Word	4	R	Bit 5	Monitored Tank Low Level	1		Each respective bit indicates the recognized warning. Useful for debugging/further investigation. If zero, system does not recognize warning.
			Bit 4	Bulk Ammonia Low Level			
			Bit 3	Bulk Chlorine Low Level			
			Bit 2	Volume Limited (Over)			
			Bit 1	Loss of Circulation Detected			
			Bit 0	Loss of Flow Detected			
Error Word	5	R	Bit 10	Total Chlorine Out of Range	1		Each respective bit indicates the recognized error. Useful for debugging/further investigation. If zero, system does not recognize error.
			Bit 9	Operation Mode Error			
			Bit 8	Degassing Routine Error			
			Bit 7	Loss of Flow Error			
			Bit 6	Unaccounted Bulk Storage Loss			
			Bit 5	Circulation Error			
			Bit 4	Sample Pump Error			
			Bit 3	Mixer Error			
			Bit 2	Chemical Feed Error			
			Bit 1	Chlorine Valve Error			
			Bit 0	Ammonia Valve Error			
Output Word	6	R	Bit 5	Return Pump Motor	1		Each respective bit indicates the status of the controller output. Useful for debuggin/further investigation.
			Bit 4	Sample Motor			
			Bit 3	Mixer Motor			
			Bit 2	Motive Valve Select			
			Bit 1	Chlorine Valve Select			
			Bit 0	Ammonia Valve Select			
Automated Management Mode Status	7	R	0x0000	Continuously Monitoring Water Quality	1		Automated Management Mode Status. Low byte. Will not take action until Data Establishment has occurred. Behavior and action setpoints controlled by additional registers.
			0x0020	Transition to Chlorine Feed			
			0x0021	Feeding Chlorine			
			0x0025	Det. Wait Period After Chlorine Feed			
			0x0030	Transition to Chloramine Feed			
			0x0031	Feeding Chloramine			
			0x0035	Det. Wait Period After Chloramine Feed			
			0x0070	Standby			
			0x0075	Data Establish. Wait Period			
			0x008F	Error Detected			

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Setting Range		Mult.	Units	Description
Auto. Time	8	R			10	Mins	Time remaining for current Automated action
Manual Dosing Mode Status	9	R	0x0000	Inactive	1		Manual Dosing Mode Status. Low byte. Requires rising edge transition of Enable Dose register.
			0x0010	Queue			
			0x0020	Flush Transition (Pre-dose)			
			0x0031	Dosing Ammonia			
			0x0032	Dosing Chlorine			
			0x0033	Dosing Chloramine			
			0x0050	Flush Transition (Post-dose)			
			0x0060	Complete			
			0x0070	Standby			
			0x008F	Error Detected			
Manual Dose Vol.	10	R			100	Gals	Volume remaining for current Manual Dosing action
Maintenance Mode Status	11	R	0x0000	Inactive	1		Maintenance Mode Status. Low byte. Valve settings and pump control set with Maintenance Setting register
			0x0010	User Selection			
			0x0070	Standby			
			0x008F	Error Detected			
Control Residual	12	R			1000	ppm	Recent Chlorine Residual Average
Remote Enable	13	R	0x0000		1		Bit signifying if remote control (i.e. Modbus) is currently allowed. If enabled, Maintenance Mode cannot be used.
			0x0001				
Last Dose Date	14	R	0xMMDD		1		Last dose date. Upper byte month. Lower byte day of month.
Last Dose Time	15	R	0xHHMM		1		Last dose time. Upper byte hour. Lower byte minute.
Last Dose Mode	16	R	0x0000	Automated Management	1		Last dose mode
			0x0010	Manual Dosing			
Last Dose Type	17	R	0x0000	None	1		Last dose chemical type
			0x0010	Ammonia			
			0x0020	Chlorine			
			0x0030	Chloramine			
Last Dose Chlorine	18	R			100	Gals	Volume of last recorded chlorine dose
Last Dose Amm.	19	R			100	Gals	Volume of last recorded ammonia dose
Sample Current	20	R			1000	Amps	Sample Pump motor current
Mixer Current	21	R			1000	Amps	Submersible Mixer motor current
Daily Chlorine	22	R			100	Gals	Total daily volume (from 00:00) of chlorine injection
Daily Ammonia	23	R			100	Gals	Total daily volume (from 00:00) of ammonia injection
Param. Ch. ID	24	R			1		Modbus Register Address of the last Parameter Changed
Param. Ch. Value	25	R			X	X	Modbus Register Value of the last Parameter Changed
Low Lvl Chlorine	26	R	0x0000		1		Bit signifying if a low level has been detected with the Chlorine Bulk Storage
			0x0001				
Low Lvl Ammonia	27	R	0x0000		1		Bit signifying if a low level has been detected with the Ammonia Bulk Storage
			0x0001				
Low Lvl Tank	28	R	0x0000		1		Bit signifying if a low level has been detected with the Monitored Tank
			0x0001				

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Setting Range		Mult.	Units	Description
Analog Input Spare	31	R			NA		Value for spare analog input on PLC
Total Vol. Chlorine	32	R			100	Gal	Total volume of chlorine injection
Total Vol. Ammonia	33	R			100	Gal	Total volume of ammonia injection
Free Chlorine	34	R			1000	ppm	Free Chlorine Residual Recent Average

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Default	Setting Range		Mult.	Units	Description
Circulation Pumps	51	R/W	0	0		1		Sample and Return Pump Control.
				1				
Tank Mixer	52	R/W	0	0		1		Must be On to allow dosing.
				1				
Reset Motors	53	R/W	0	0		1		Sample, Return (VFD), Mixer
				1				
Mode Select	54	R/W	0x0020	0x0000	Automated Management	1		Low byte. Due to self flushing, cleaning, and draining of system station may not immediately transition to selected mode. Maintenance is disabled if Remote Enable is high, which is set locally via the HMI under *Config.* > *Internal Parameter*s
				0x0010	Manual Dosing			
				0x0020	Manual Feed			
				0x0030	Maintenance			
Reset Modes	55	R/W	0	0		1		Reset Modes (All)
				1				
Reset Memory	56	R/W	0	0		1		Reset Memory (All)
				1				
Residual Target	57	R/W	3.000	0.00		1000	ppm	Desired chlorine residual setpoint (ppm). See manual for more detailed information regarding residual targets and recovery thresholds.
				20.00				
Crossover target	58	R/W	3.000	0.00		1000	ppm	Desired crossover setpoint (ppm). See manual for more detailed information regarding residual targets and recovery thresholds.
				20.00				
Chloramine Override	59	R/W	0	0		1		Chloramines will exclusively be used to recover to residual setpoint
				1		1		
Enable Dose	60	R/W	0	0		1		Enable manual chemical dose.
				1				
Chemical Type	61	R/W	0x0000	0x0000	None	1		Desired chemical type for Manual Dosing or Feed Modes
				0x0010	Ammonia			
				0x0020	Chlorine			
				0x0030	Chloramine			
Dose Amount	62	R/W	0	0.00		100	Gals	Desired dose amount for Manual Dose or Feed. Dosing or Feed will be disabled if Volume Limit is reached
				330.00				
Continuous Dose	63	R/W	0	0		1		Allows manual dose to continuously dose (feed) selected chemical. Limited by Daily Volume Limit settings.
				1				
Maint. Setting	64	R/W	0x0000	Bit 2	Ammonia Select Valve	1		Setting each respective bit (low byte) will enable each output. Will not allow user to select chlorine and ammonia simultaneously. Actuation timeout occurs after 30 seconds of no change on chemical valves, and will clear all after 3 minutes.
				Bit 1	Chlorine Select Valve			
				Bit 0	Motive Select Valve			
Trending Data Register Period	65	R/W	1	0		1	Mins	System will register trending and logged values at this interval.
				32767				
Residual Trend Points	66	R/W	5	0		1		Number of recent data points to be averaged and used for trending data determinations
				32767				
Data Establish. Duration	67	R/W	30	0		1	Mins	Length of time system waits once in Automated Management for readings to stablize before acting
				32767				
Action Timeout	68	R/W	720	0		1	Mins	If last dose was not made within this timeout duration, prior actions will not be considered (for Automated Management decisions)
				32767				
Feed Duration	69	R/W	30	0		1	Mins	Amount of time the system will feed a chemical before stopping to wait and see the effect (for Automated Management decisions)
				32767				

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Default	Setting Range		Mult.	Units	Description
Determination Wait Time	70	R/W	240	0		1	Mins	Amount of time after system has stopped chemical feed before making trend or threshold determination (for Automated Management decisions)
				32767				
Determination Hysteresis	71	R/W	5	*		1	Mins	Number of minutes system waits before checking if threshold crossing was false positive. Setting must be greater than the Trending Data Register Period, and less than Confirmation Wait.
				*				
Confirmation Wait	72	R/W	45	0		1	Mins	Number of minutes a threshold crossing must hold before determination is considered complete. Setting must be less than Determination Wait Time.
				*				
Descrease Threshold	73	R/W	0.500	0.000		1000	ppm	When chlorine residual drops below this point, system will take action (for Automated Management decisions). Setting must be less than Residual Setpoint.
				*				
Recovery Threshold	74	R/W	0.150	0.000		1000	ppm	When chlorine residual increases above this point, system will consider setpoint reached (for Automated Management decisions). Setting must be less than Decrease Threshold.
				*				
Recovery Attempt Limit	75	R/W	3	0		1		Number of attempts Automated Management will make to recognize a residual increase
				32767				
Breakpoint Threshold	76	R/W	0.500	0.00		1000		Ratio of Free Chlorine to Total Chlorine. When this limit is exceeded, the system considers a Breakpoint Location detected (for Automated Management decisions)
				1.00				
Flow Rate	77	R/W	1.000	0.00		1000	GPH	Flow rate of the set/commanded chemical.
				2.50				
Feed Ratio	78	R/W	4.200	0.00		1000		Ratio of Cl2:NH3-N
				5.00				
Ratio Factor	79	R/W	1.630	0.00		1000		Ratio of (Wt. NaClO (lbs/G) * % Avail. Cl2):(Wt. LAS (lbs/G) * % Avail. N)
				10.00				
Motor Current Limit	80	R/W	10	0		1	%	Over/Undercurrent Limit for Sample Pump and Mixer
				100				
Sample Current Setpoint	81	R/W	12.000	0.00		1000	Amps	Sample Pump motor typical operating current
				20.00				
Mixer Current Setpoint	82	R/W	12.000	0.00		1000	Amps	Submerisble Mixer motor typical operating current
				20.00				
Daily Volume Limit Chlorine	83	R/W	12.000	0.00		1000	Gals	Once this limit is reached, the system will no longer allow itself to feed until the next day.
				330.00				
Daily Volume Limit Ammonia	84	R/W	12.000	0.00		1000	Gals	Once this limit is reached, the system will no longer allow itself to feed until the next day.
				330.00				
Unaccounted Change Limit	85	R/W	10.00	0.00		100	%	Bulk storage monitor. If the storage sensor reports an unaccounted change (no dosing) in the set period the system will report an error.
				100.00				
Unaccounted Change Timeout	86	R/W	15	0		100	Hrs	Bulk storage monitor. If the storage sensor reports a change greater than the limit during this time period, the system will error.
				24				
Unaccounted Change Clear	87	R/W	0	0		1		Bulk storage monitor. Resets the memory buffer in the event of tank fill, drain, etc. Buffer is also cleared with Memory Reset.
				1				
Low Level Alert Chlorine	88	R/W	15	*		100		Alert when external sensor signal is below setting. Limits set locally at HMI with MIN and MAX limit settings when configuring sensor.
				*				
Low Level Alert Ammonia	89	R/W	15	*		100		Alert when external sensor signal is below setting. Limits set locally at HMI with MIN and MAX limit settings when configuring sensor.
				*				
Low Level Alert Monitored Tank	90	R/W	15	*		100		Alert when external sensor signal is below setting. Limits set locally at HMI with MIN and MAX limit settings when configuring sensor.
				*				

Modbus Registers

Defaults, Values and Descriptions

Name	Addr.	R/W	Default	Setting Range		Mult.	Units	Description
Degas Enable	91	R/W	1	0		1		Enable the degassing scheme. Exercises valves to mitigate gas accumulation in lines, valves, etc.
				1				
Min. Chlorine Alarm Setpoint	92	R/W	1	0		1000	ppm	Minimum setpoint for Total Chlorine level alarm
				65,535				
Max. Chlorine Alarm Setpoint	93	R/W	1	0		1000	ppm	Maximum setpoint for Total Chlorine level alarm
				65,535				
Bulk Chlorine Level	94	R/W	1	0		10		Bulk Chlorine tank level
				65,535				
Bulk Ammonia Level	95	R/W	1	0		10		Bulk Ammonia tank level
				65,535				
Monitored Tank Level	96	R/W	1	0		10		Monitored tank level
				65,535				

Datalogging

Parameters and Format

Information Logged

If a USB flash drive (min. 1GB/max. 16GB) is inserted into the rear of the HMI, the system automatically creates two text files (.txt) logs to record system operational data. Up to 3000 events are recorded in the Event Log, while up to 500 events are recorded in the Alarm Log. Each is managed in a circular format, overwriting the oldest values.

Event Log			Alarm Log		
“VarName”	:	Variable Name	“Time_ms”	:	Value / 1E6 = Days Since 1/1/1900
“TimeString”	:	Time of Event	“MsgProc”	:	Disregard
“VarValue”	:	Variable Value	“StateAfter”	:	1 = Active, 0 = Inactive
“Validity”	:	Valid Entry	“MsgClass”	:	64 = Warning, 65 = Error
“Time_ms”	:	Value / 1E6 = Days Since 1/1/1900	“MsgNumber”	:	Warning/Alarm ID
			“TimeString”	:	Time of Event

Reviewing Logs (Events and Alarms)

- Prior to removal of the USB flash drive from HMI, close logs by pressing *Local Log Stop* at *Base* > *Configure* > *System 2*
- Logs will automatically start upon system startup/restart. However, if logs are closed during operation they must be restarted once the USB is inserted by pressing *Local Log Start* at *Base* > *Configure* > *System 2*
- Alarm Log entries are available for viewing at *Base* > *Monitor* > *Alarms*
- Event variables and Warning/Alarm indicators are available for monitoring via Modbus. See *Modbus Parameter Tables* for more information

Variables Logged

Values saved as either 32-bit floating point, single-precision numbers or 16-bit words. Formatting of 16-bit word values are scaled according to *Modbus Parameter Tables*.

Event Log:

- Residual Chlorine
- Operational Mode
- Last Dose Ammonia
- Last Dose Chlorine
- Output Code
- Parameter Change (ID and Value)
  - ID = Modbus Register Address
  - Value = Modbus Register Value

Alarm Log:

- Warning Code
- Error Code

Troubleshooting

Errors:

The table below summarizes system Errors. The following will stop any active chemical feeds, and disable future chemical feeds until the specific error is cleared.

Alarm Message	ID	Problem/Conditions	Possible Cause	Possible Solution(s) or Next Step(s)
Ammonia Valve Error OR Chlorine Valve Error	100 OR 101	Flow volume cannot be confirmed for respective valve	Empty Bulk Storage	Visually inspect bulk storage tanks, chemical feed lines, and isolation valves for proper status and position.
			Valve Closure	
			Chemical Line Disconnected	
			Flow Verification Sensor Error	Visually inspect respective flow verification sensor paddlewheel. May also verify input to controller by viewing *Base* > *Operate* > *Maintenance* or *Base* > *Admin* > *I/O*.
Feed Controller Error	102	Rinse Valve actuation cannot be confirmed	Valve Motor Failure/Valve Seized	Attempt to manually (Maintenance Mode) actuate the Rinse Valve, and observe indicator on top of valve. If appears to be functioning, likely a failed limit switch.
			Limit Switch Failure	
Mixer Error	103	Monitored current is out of range (over/undercurrent)	*See Mixer documentation for details*	-
Sample Pump Error	104	Monitored current is out of range (over/undercurrent)	Current Limit Nuisance Trip	Current Limit setpoint is incorrect, or too restrictive. Default of 10%.
			High or low line voltage	Monitor incoming source power
			Locked rotor or bound pump	*Contact Ixom Watercare, Inc. for further troubleshooting*
Circulation Monitor Error	105	Circulation pumps are no longer running	Float switch may be active	Check to see the Sample Pump is commanded to RUN by viewing *Base* > *Monitor.* If so, visually inspect run indicator light on the Sample Pump Control Box. If the HOA switch is in AUTO and the light is OFF, likely an activated float switch.
			Sample Pump Error	See above
			Pre-Mix Tank Level Error	Visually inspect the Pre-Mix Tank for fill level. If the tank appears empty, the pump may need to be primed. If the tank is nearly full, the pump may need to be run manually to return the tank to an acceptable level. This can be done by turning *Circulation Pumps* OFF at *Base* > *Operate*, then temporarily placing the VFD in HAND.

Troubleshooting

Errors cont'd:

The table below summarizes system Errors. The following will stop any active chemical feeds, and disable future chemical feeds until the specific error is cleared.

Alarm Message	ID	Problem/Conditions	Possible Cause	Possible Solution(s) or Next Step(s)
Unaccounted Change of Bulk Storage Error	106	An unaccounted-for change has been witnessed on either of the two bulk storage inputs.	Tank Drain or Fill	Press *Bulk Clear* at *Base* > *Monitor* > *Tanks* immediately after a Tank Drain or Tank Fill has occurred to prevent an error from being reported.
			Tank Spill or Leak	Inspect all tanks, lines, and fittings connecting to the bulk storage tanks.
Flow Verification Error	107	Verification scheme cannot confirm proper flows	Lack of/No Feedback from sensor	Visually inspect respective flow verification sensor paddlewheel. May also verify input to controller by viewing *Base* > *Operate* > *Maintenance* or *Base* > *Admin* > *I/O*.
			Low/High Flow Condition	Verify flooded suction to chemical inputs. When actively feeding chemical, the Rinse Pressure Regulator should be adjusted so the Rinse Valve reports flow values of approximately 7.5 GPH.
			Incorrect Feedback	Possible plugging, or other sensor issue. *Contact Ixom Watercare, Inc. for further troubleshooting.*
Automated Management Error	200	Mode Fault	Recovery Fault	System has attempted to recover residual without positive result the maximum number of times. Verify chemical has been fed at expected volumes. If so, Change Time and/or Flow Rate could be increased. Additionally, Determination Times should be considered with recent tank usage (potentially needs to be increased/decreased).
			Breakpoint Detected	Check chlorine sensor transmitter(s) and associated output(s). If false alarm, Breakpoint Threshold could potentially be increased [Default 0.50 (50%)].

Troubleshooting

Warnings:

The table below summarizes system Warnings. The following may self-correct, but could adversely impact system performance.

Alarm Message	ID	Problem/Conditions	Possible Cause	Possible Solution(s) or Next Step(s)
Loss of Flow Detected	300	System has momentarily lost ability to confirm proper flows	Non-critical warning	If issue persists, or becomes more frequent, could signify maintenance is required on flow verification sensors. *See Maintenance documentation for more details.*
Loss of Circulation Detected	301	System has momentarily lost circulation	Non-critical warning	If issue persists, or becomes more frequent, could signify issues with Pre-Mix Tank, Sample Pump, or Return Pump. *See Maintenance documentation for more details.*
Daily Volume Limit Reached	302	System has fed the maximum allowed chemical volume in 24 hour period.	Incorrect settings	Non-critical warning. Will self-correct clear at 0:00. Verify feed settings are appropriate for recent flows and residual levels.
			Increased chemical demand	
Low Bulk Chlorine Level Detected	303	Level reported is below alert setpoint	Low level in chlorine bulk tank	Non-critical warning. Ensure low level is not due to leaks/spills. Refill if necessary.
			Incorrect settings/scaling factors	Check sensor/transducer scaling, and thresholds at *Base* > *Configure* > *Data.*
Low Bulk Ammonia Level Detected	304	Level reported is below alert setpoint	Low level in ammonia bulk tank	Non-critical warning. Ensure low level is not due to leaks/spills. Refill if necessary.
			Incorrect settings/scaling factors	Check sensor/transducer scaling, and thresholds at *Base* > *Configure* > *Data.*
Low Monitored Tank Level Detected	305	Level reported is below alert setpoint	Low level in monitored tank	Non-critical warning. Ensure low level is not due to leaks/spills. Refill if necessary.
			Incorrect settings/scaling factors	Check sensor/transducer scaling, and thresholds at *Base* > *Configure* > *Data.*

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