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Contingency Base Energy Management System (CB-EMS): Installation Manual

September 2026

JC Tucker
JK Goddard



U.S. DEPARTMENT
of ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Pacific Northwest National Laboratory
Richland, Washington 99354

Abstract

Contingency bases, also known as expeditionary bases and forward operating bases, are used by the Army at temporary sites to allow military forces to perform expeditionary warfare, humanitarian efforts, and disaster relief. Because of their remote locations, contingency bases are often powered by generators, which require a considerable amount of fuel. The high cost of delivering fuel to these sites, along with the risk to personnel delivering that fuel, makes energy efficiency a high priority.

The Contingency Base Energy Management System (CB-EMS) is a software application that enables the camp manager to monitor camp energy operations and identify issues that can cause excessive energy consumption. It also gives camp managers real-time visibility of the fluid levels for all camp fuel and water tanks, as well as the consumption to estimate how long the current reserves will last. Instrumentation throughout the camp provides information to the system. These include the structure temperature, energy usage, and generic metering to monitor other parameters. Generators are monitored for performance to maintain system efficiency. Solar photovoltaic arrays are monitored by CB-EMS to allow efficient operation of those resources.

CB-EMS is built using Ignition by Inductive Automation as the Supervisory Control and Data Acquisition (SCADA) platform. Ignition runs using Java within their Vision Client Launcher. CB-EMS uses instrumentation throughout the camp to create an energy “dashboard” to enable the camp manager to view the camp and identify areas where the camp is outside operational guidelines.

This user manual is intended to enable camp managers to work with the system. A separate manual for the CB-EMS administrator details how the camp dashboard is configured for a new site and how to apply changes to an existing site, and a third manual is provided to document how to set up a new system head end.

Acronyms and Abbreviations

CB-EMS	Contingency Base Energy Management System
JDBC	Java Database Connectivity
MS	Microsoft
SCADA	Supervisory Control and Data Acquisition
SSMS	SQL Server Management Studio

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1.0 Introduction

The Contingency Base Energy Management System (CB-EMS) is a government-owned expert system designed to integrate site operations and energy management at contingency bases. Contingency bases, or base camps, are non-enduring locations outside the United States that support and sustain operations during contingencies or other operations and are categorized by mission life-cycle requirements as initial, temporary, or semipermanent. CB-EMS enables base camp managers to operate and manage their camps in the most effective and efficient manner.

CB-EMS provides detailed information on camp operations that allows the camp manager to identify issues related to important functions such as power, fuel consumption, water consumption, and equipment maintenance. The main “dashboard” screen provides a quick visual representation of the camp and highlights areas that are outside operational parameters. Once an issue is identified, CB-EMS provides the camp manager with detailed information that enables them to identify the problem and act accordingly. CB-EMS also monitors fuel and water supplies, offers the camp manager an indication of how much of these resources the camp is consuming, and predicts the amount of time left before the available fuel and water are consumed.

When deployed, CB-EMS provides detailed information for the camp manager to run the base efficiently. In addition to reducing energy use (and thus energy consumption) at the camp, it also provides the following benefits:

- Fuel and water consumption information improves camp readiness
- Efficient operation of generators extends equipment life
- Maintenance staff workload is reduced
- Maintenance parts and labor costs are reduced

CB-EMS is designed to be user configurable to allow the CB-EMS administrator to add new resources during operations and remove them as the camp changes. This plug-and-play capability allows the software to be customized on the fly as the camp changes. Separate manuals for the CB-EMS administrator and user provide instructions for changing the camp dashboard as equipment is added or removed from the camp.

2.0 Architecture

CB-EMS uses Ignition by Inductive Automation to provide the graphics to display data, organize the connections to the equipment providing signals, and manage the database to store data. Ignition is compatible with several commercially available databases. Microsoft (MS) SQL Server was selected for CB-EMS because of its ease of use and the security available within the software. Most CB-EMS head end systems will use MS SQL Server Express, which can be installed free of charge. In some cases, the full MS SQL Server will need to be installed, and that process is nearly identical to the process for MS SQL Server Express covered here. MySQL was also implemented for and only used at one test site. This installation manual will not cover the installation of that option.

The information contained in this manual related to installing Ignition and Installing MS SQL Server can also be found in the documentation for Ignition. It is provided here for convenience.

3.0 Installation Media

As mentioned above, installing CB-EMS requires installing both MS SQL Server and Ignition, which are available from Microsoft and Inductive Automation, respectively. Once those two applications are installed, the CB-EMS database must be installed on the system; then, both software packages must be configured to communicate with each other. Finally, the CB-EMS project must be restored to the Ignition gateway for the software to operate.

The files listed below are provided to install CB-EMS on a new head end unit. Newer versions of the software can be installed, and the process should be very similar.

- Ignition-8.3.8-windows-64-installer.exe. The most recent installation media for Ignition as of this writing and is required for CB-EMS to operate.
- SQLEXPRESS_x64_ENU.exe. The SQL Express installer for version 17.0. Newer versions can be installed, but version 17.0 was the last to provide an easy offline installer.
- SSMS-Setup-ENU.exe. The installer for SQL Server Management Studio (SSMS) version 21.0. This is the last version available with a simple offline installer as of this writing. Newer versions should work fine, and the installation process should be similar.
- Sqljdbc_9.4.0.0_enu.zip. This contains the Java Database Connectivity (JDBC) files required for Ignition to use Windows Security for access to the database.
- CB-EMS_30.gwbk. The gateway backup file that contains the CB-EMS software. It's used during the installation to install the CB-EMS project on Ignition.
- CBEMS_dB.bak. Backup file of a blank CB-EMS database. It is used to restore the database on a new CB-EMS install.
- SSHQuery.zip. This contains the program that connects to the radios via SSH to gather connection strength information.
- dotnet-runtime-8.0.26-win-x64.exe. Installer for Microsoft .NET runtime 8.0. This utility is required for the SSHQuery software to run.

4.0 Add svc_CBEMS User

A Windows user account must be created with administrative privileges. This user account is a local account and should be named svc_CBEMS. Windows Account Manager can be used to create this account. In the Settings app, select *Accounts > Other Users* (Figure 1).

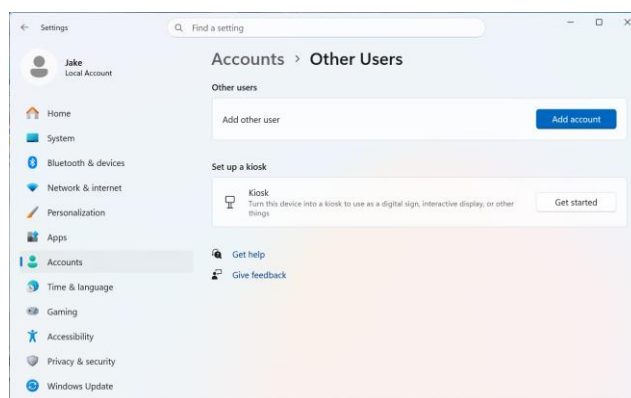


Figure 1. Creating a Windows account.

Press the *Add Account* button under Add other user. In the new window (Figure 2), name the account svc_CBEMS and use the password you have been provided separately. Windows requires security questions to be selected for a new account. Do not use personal information.

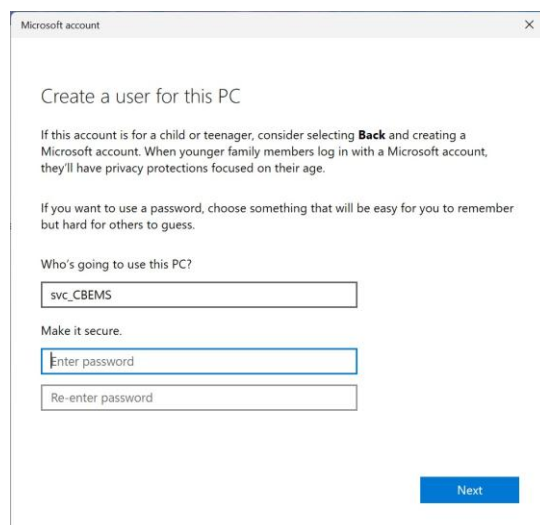


Figure 2. Adding an account.

Once the account is created, you must change the account type to Administrator. To do that, select the svc_CBEMS user from the list and choose change account type (Figure 3).

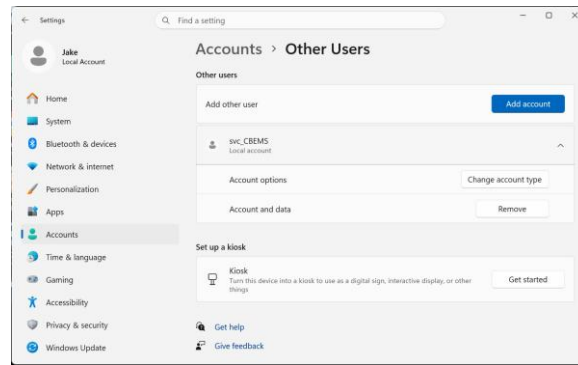


Figure 3. Account selection.

From that list, choose *Administrator* to make the svc_CBEMS account an administrator (Figure 4).

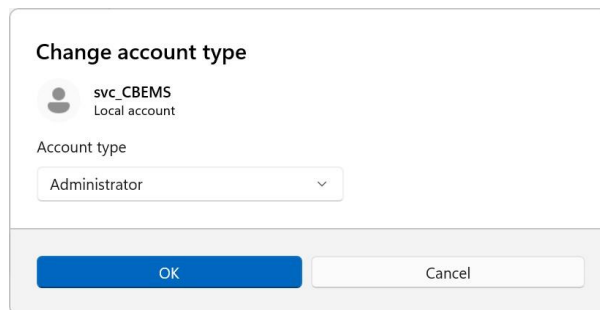


Figure 4. Changing account type.

5.0 MS SQL Express Installation

These instructions will guide you through installing MS SQL Express, version 2025. Installing other versions of MS SQL is a very similar process. Version 2025 of MS SQL Express is the first version to extend the 10 GB database limit to 50 GB, which is important for CB-EMS. Double-click SQLEXPRESS_x64_ENU.exe to execute the installer. Select a location for the files to be extracted.

The installer will open. Select *New SQL Server standalone installation or add features to an existing installation* (Figure 5).

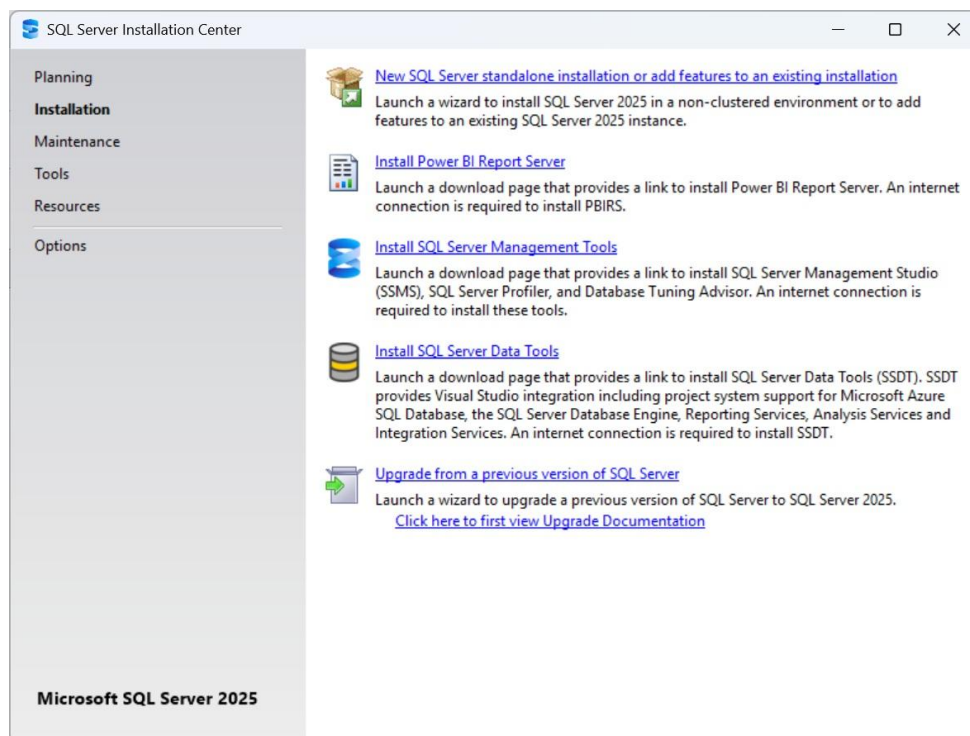


Figure 5. SQL Server Express 2025 installation.

Check the box stating that you accept the license terms and privacy statement and press *Next* to continue. Do not select *Use Microsoft Update to check for updates*. The CB-EMS head end unit is not required to be connected to the internet. Press *Next* (Figure 6).

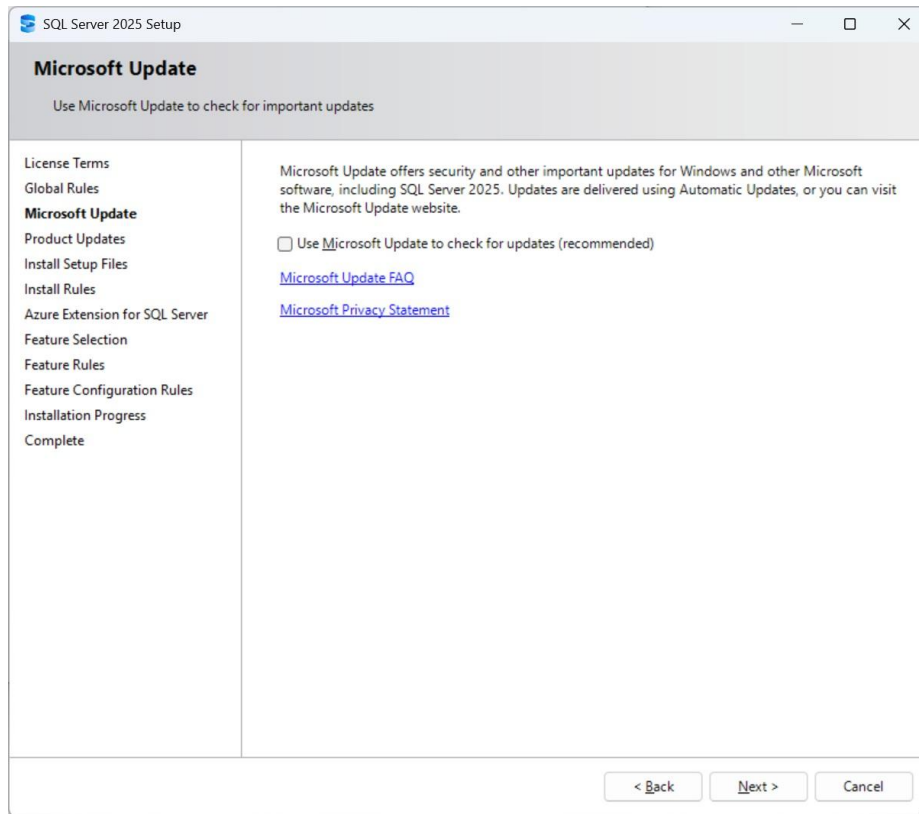


Figure 6. Do not use Microsoft Update.

If the system is not connected to the internet, an error will pop up stating that the setup couldn't connect to the update service, and you can press *Next* to continue (Figure 7).

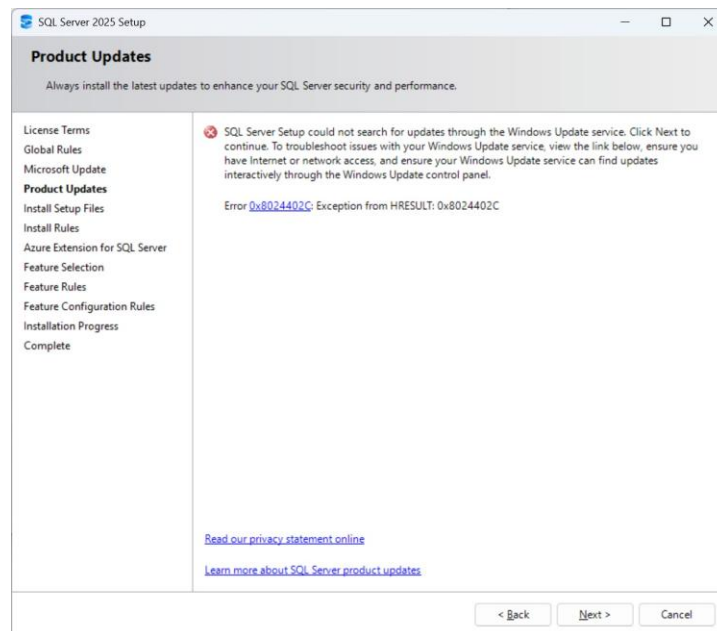


Figure 7. MS update error.

The next page will show the install rules (Figure 8). Press *Next* to continue.

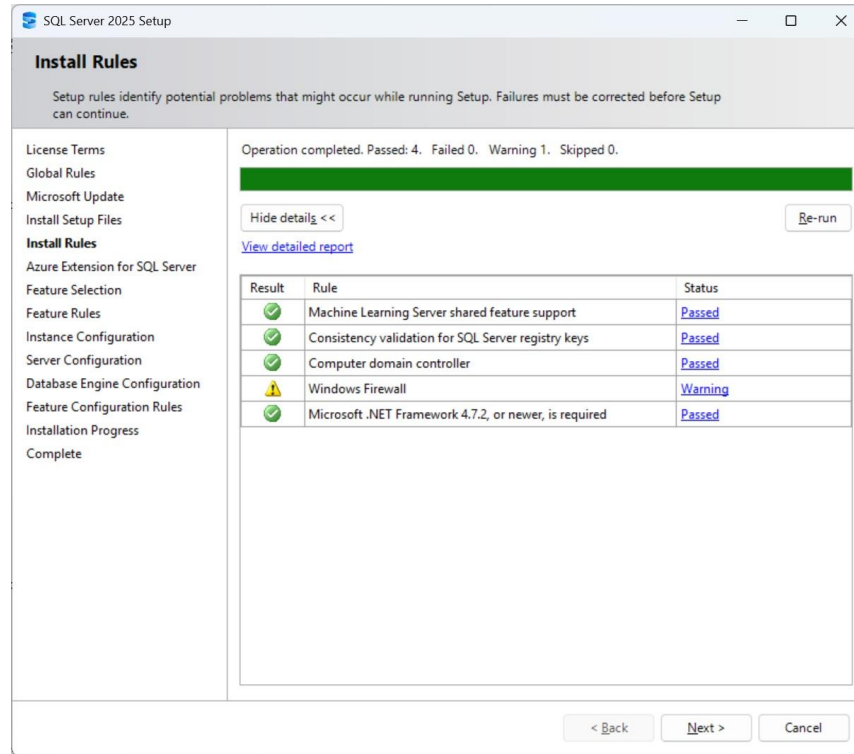


Figure 8. Install Rules page.

After the Install Rules page, the Azure Extension page will come up. Do not select Azure. Press *Next* (Figure 9).

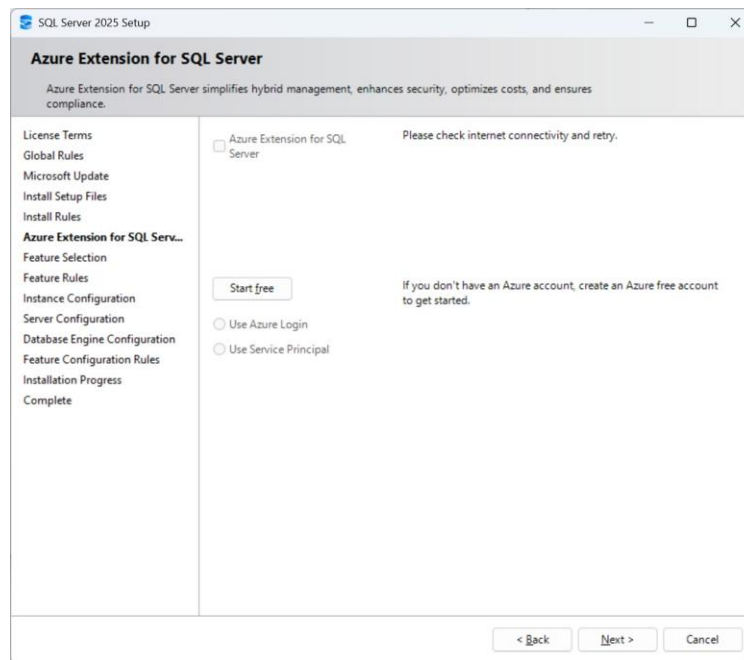


Figure 9. Azure Extension page.

The Feature Selection page shows all the features to install. Use the default selections on this page (Figure 10). Press *Next* to continue.

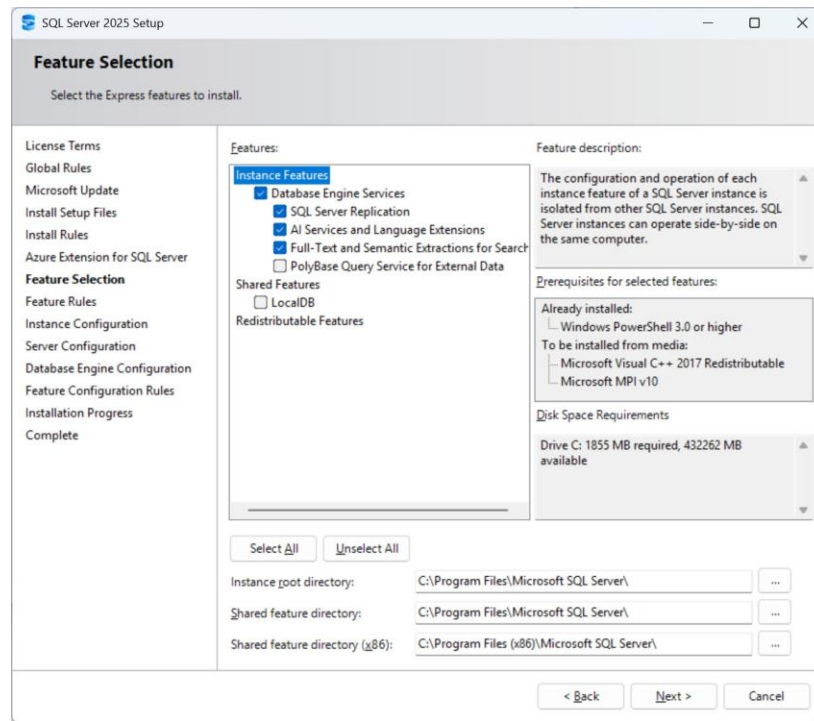


Figure 10. Feature Selection page.

The installation Configuration page is used to select a name for the instance. Use the default, SQLEXPRESS (Figure 11).

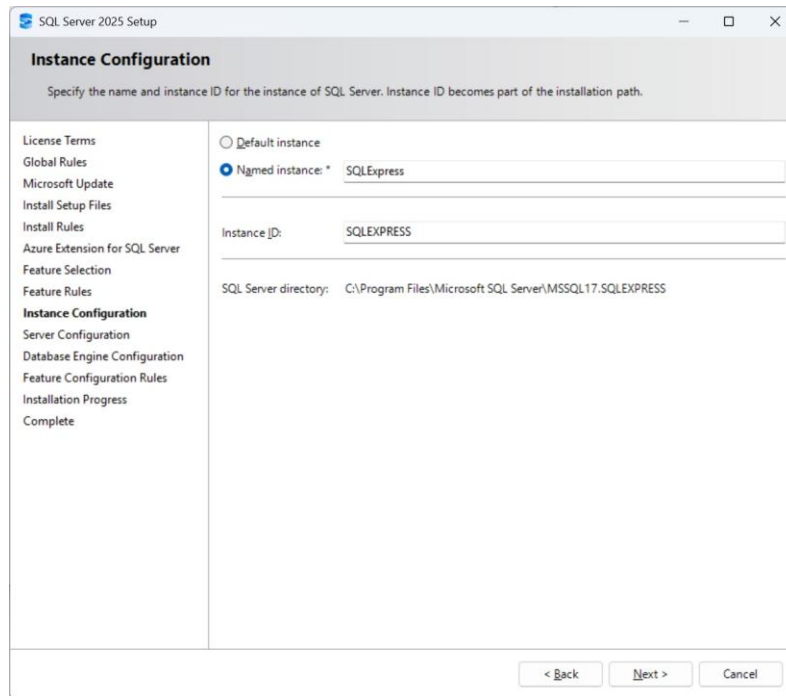


Figure 11. Instance Configuration page.

For the Server Configuration page, keep the default selection (Figure 12). Press *Next*.

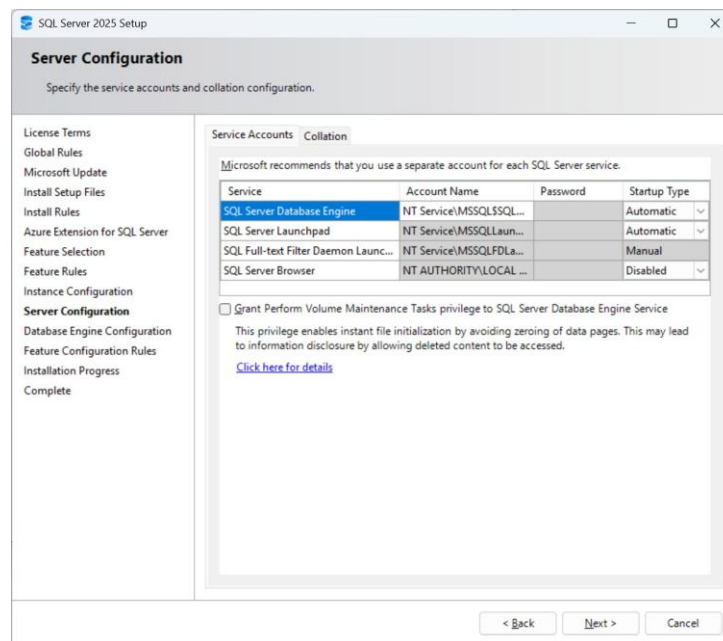


Figure 12. Server Configuration page.

For the database engine configuration (Figure 13), Select *Windows authentication mode*. Click the *Add* button at the bottom of the page to add a SQL Server administrator. From this dialog box, add the svc_CBEMS account as a SQL Server administrator and press *Next*. The current logged in user should be shown as an administrator.

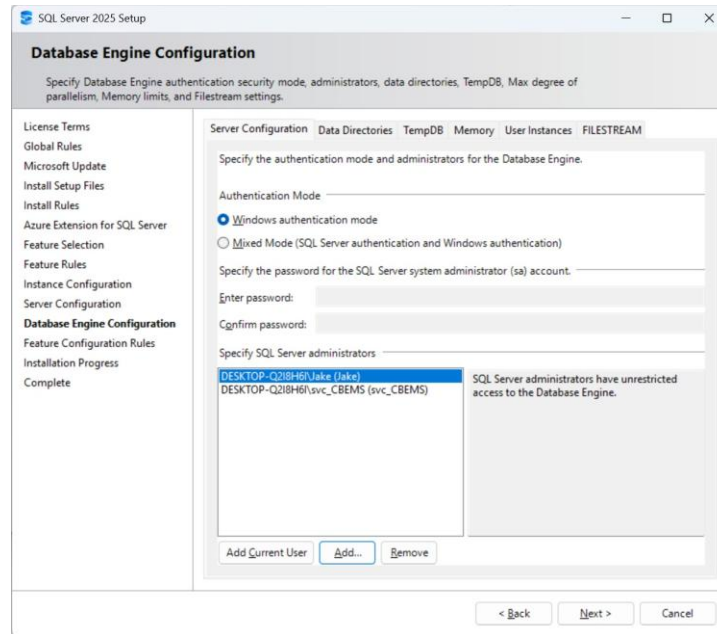


Figure 13. Database Engine Configuration page.

The full installation process will take a minute or so. Once that process is complete, press *Close* to finish the installation (Figure 14).

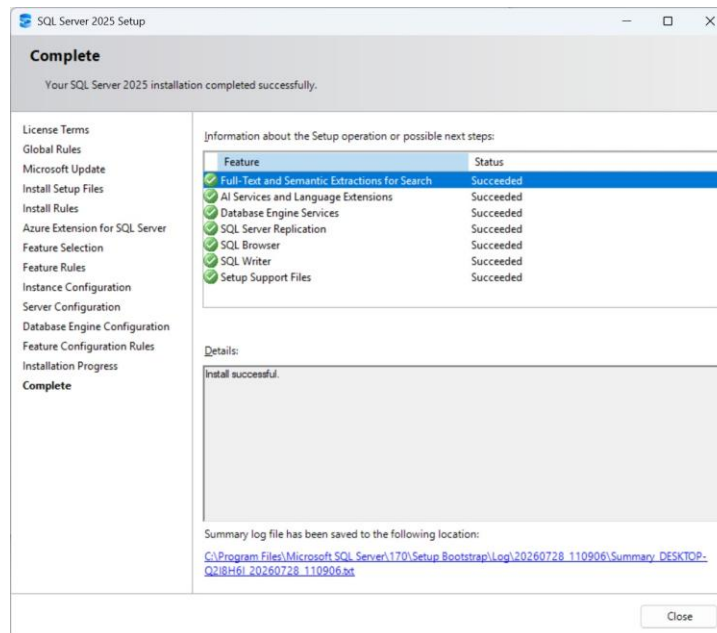


Figure 14. SQL install complete.

Now that SQL Server Express is installed, you must enable TCP/IP and change the port to a static port to connect to Ignition. Run the SQL Server Configuration Manager from the Start menu on the computer. In the tree on the left, expand *SQL Server Network Configuration* and select *Protocols for SQLEXPRESS* (Figure 15).

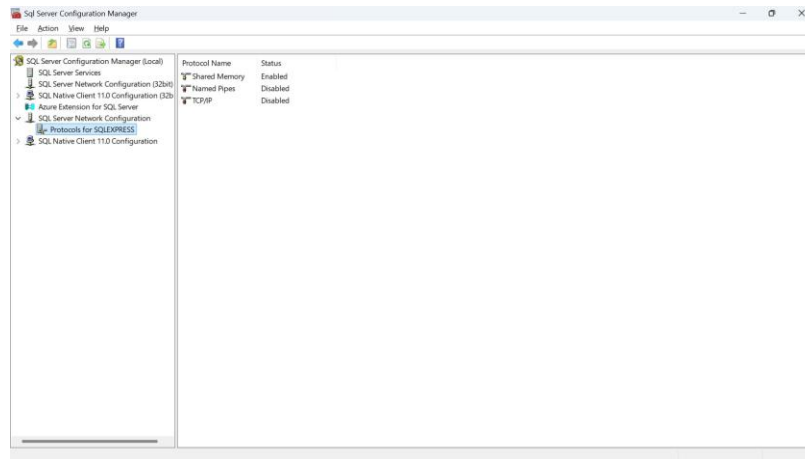


Figure 15. SQL Server configuration.

Right-click on TCP/IP and choose *Enabled*. The configuration should look like Figure 16.

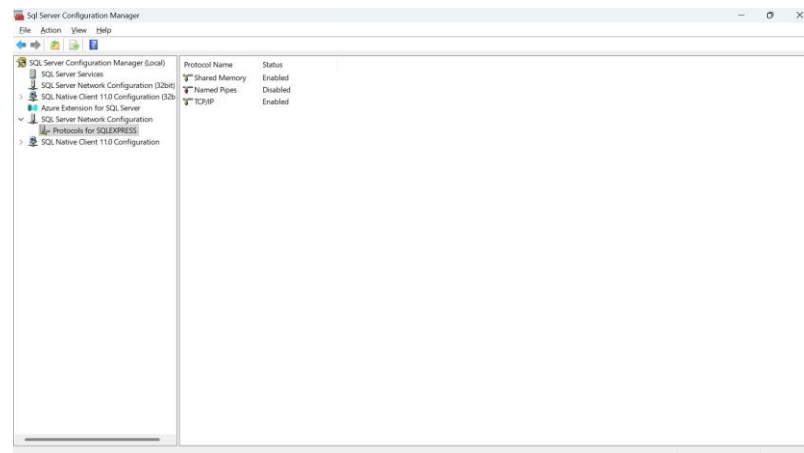


Figure 16. TCP/IP enabled.

Once that's complete, double-click on TCP/IP to open a dialog box to change to static ports. Select the *IP Addresses* tab and scroll to the bottom where it shows IPAll. Clear the number next to *TCP Dynamic Ports* and input 1433 in *TCP Port* below and hit *Apply* (Figure 17).

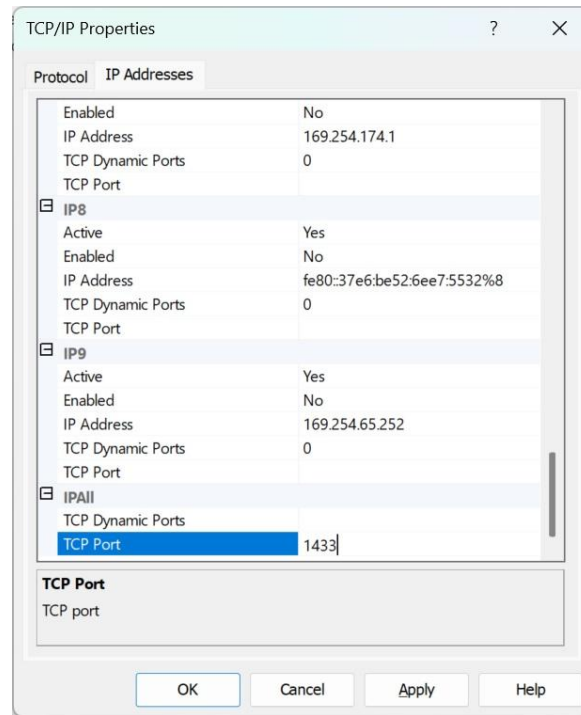


Figure 17. TCP/IP static port.

Now, restart the server by selecting SQL Server Services at the top left and then right-clicking on *SQL Server (SQLEXPRESS)* and pressing *Stop*. Once stopped, right-click again on *SQL Server (SQLEXPRESS)* and press *Start* (Figure 18).

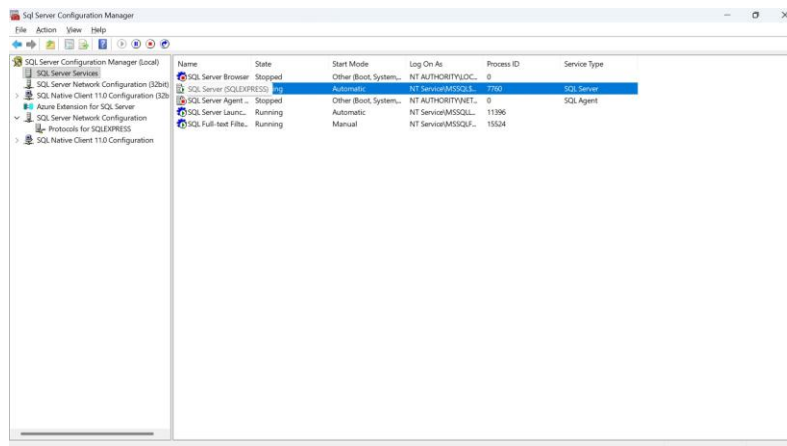


Figure 18. SQL Express stop and start.

6.0 Install SSMS

The next software to install is SSMS. SSMS version 20 is provided as it can be downloaded with a standalone installer. Execute the installer. On the start page, press *Install* to start the installation process. This installer should finish, and you can press close.

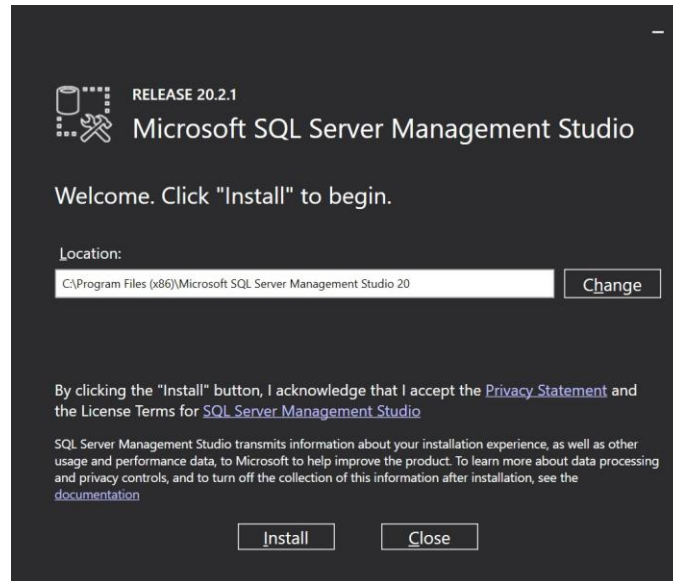


Figure 19. SSMS installation.

7.0 Add CB-EMS Databases

Once SSMS is installed, open SSMS to create the two databases. SSMS will open with the connection dialog box. The default should connect to the local database, Windows Authentication should be used, and it will show the current user. Select the *Trust server certificate* checkbox and press *Connect* (Figure 20).

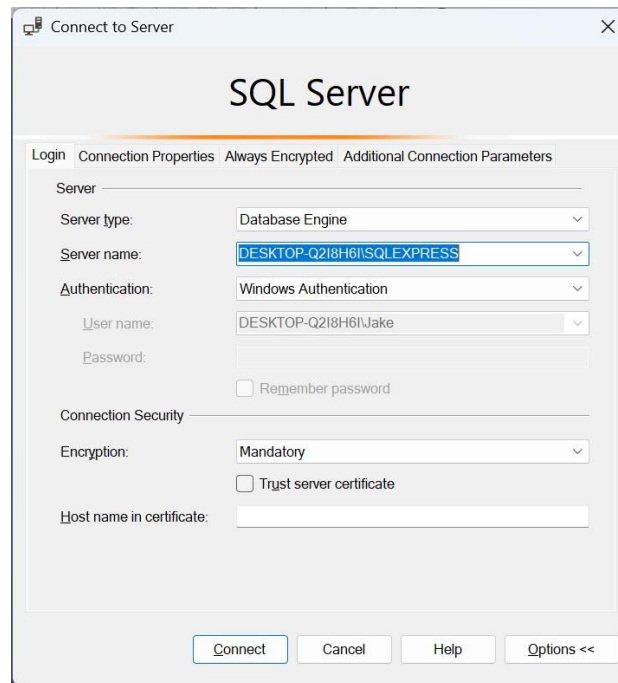


Figure 20. SSMS connection dialog box.

This will open up SSMS and connect to the local database (Figure 21).

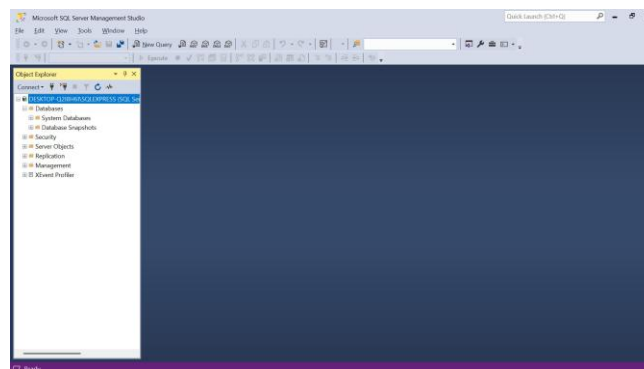


Figure 21. SSMS connected to the local database.

Right-click on the *Databases* item and choose *New Database*. Fill in the dialog box and name the database CBEMS_db (Figure 22). All other fields can be left as their defaults, and press *OK*. Follow the same procedure to create a database called CBEMS_History.

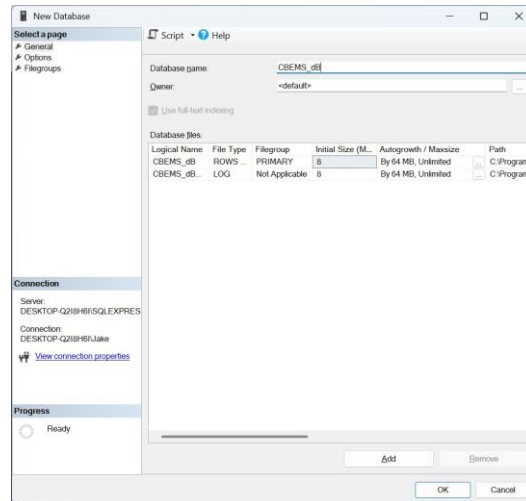


Figure 22. Database creation.

With the CBEMS_db database created, we now need to pull the database tables into the database. This can be done with a database backup file provided with the distribution. It should be copied to a directory with no spaces in the directory name, such as c:\Staging. With SSMS open, right-click on the newly created CBEMS_db database and choose *Tasks > Restore > Database*.

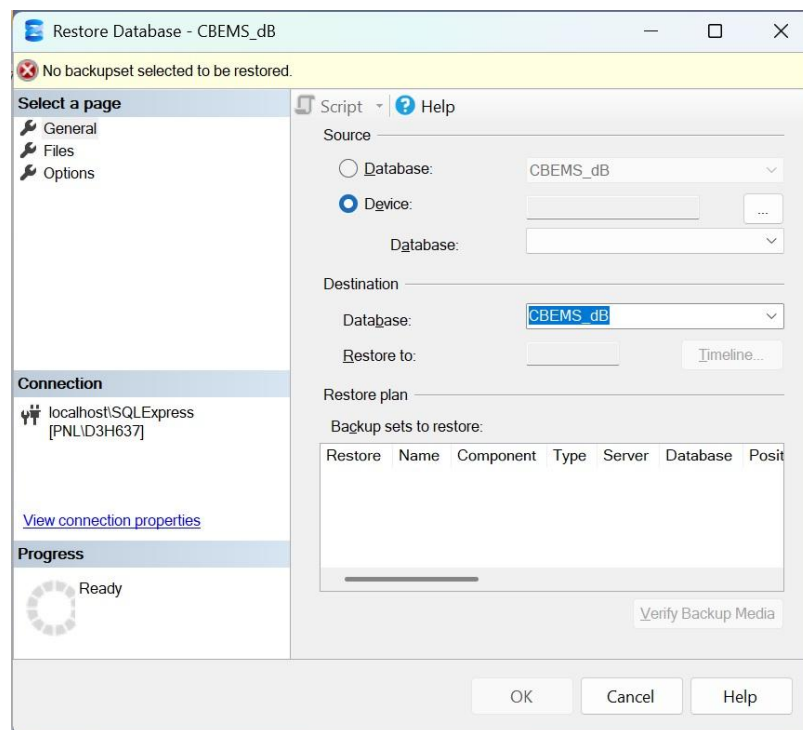


Figure 23. Restoring CBEMS_db.

Under the *General* menu item (Figure 23) choose *Device*; then, click the three dots next to the device label and press *Add*. Browse to the CBEMS_db.bak file you copied to the computer (Figure 24).

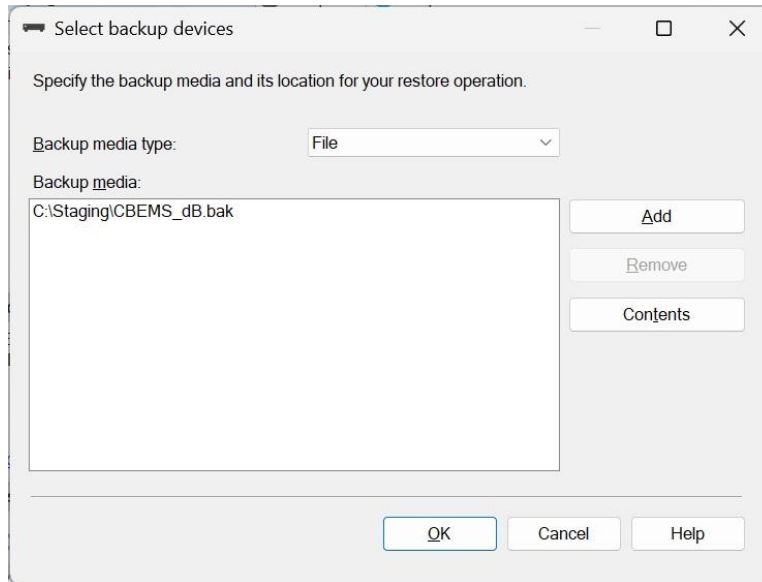


Figure 24. Select backup device.

Press **OK**; then, choose *Options* from the tree on the left. Select *Overwrite the existing database (WITH REPLACE)* and press **OK** (Figure 25).

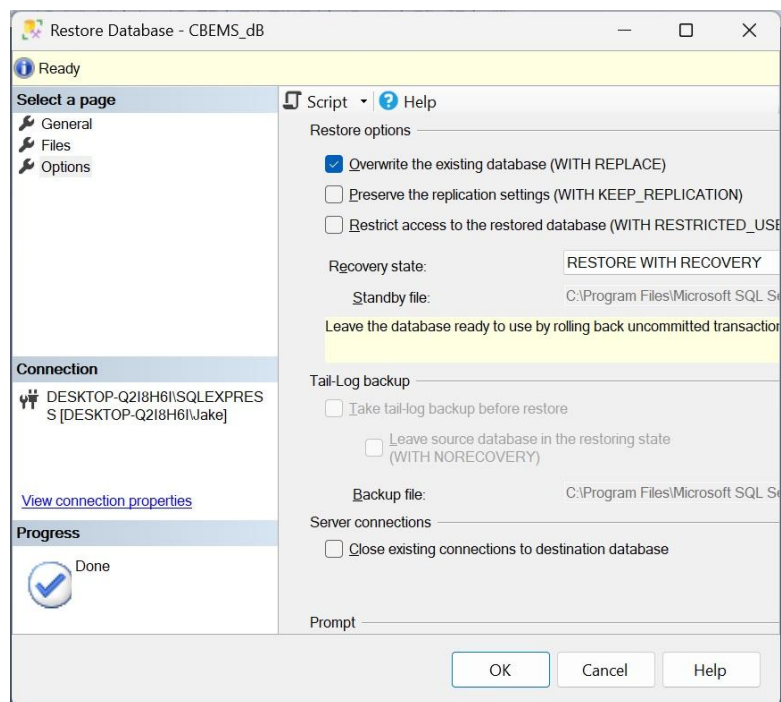


Figure 25. Restore Database window.

8.0 Installing and Configuring Ignition

Installing Ignition is a straightforward process that is facilitated by the Ignition Installer that is provided. The newest version of Ignition can be downloaded from the Inductive Automation website and can be used for CB-EMS. While newer Ignition versions are likely to operate CB-EMS without issues, it's best to contact CB-EMS staff to check which versions have been tested in the field.

8.1 Installing Ignition

The first step to installing Ignition is to run the provided executable, Ignition-8.3.8-windows-64-installer.exe. That application will guide you the process. After running the executable, the first page is an initialization page, and you can choose *Next* to proceed (Figure 26).

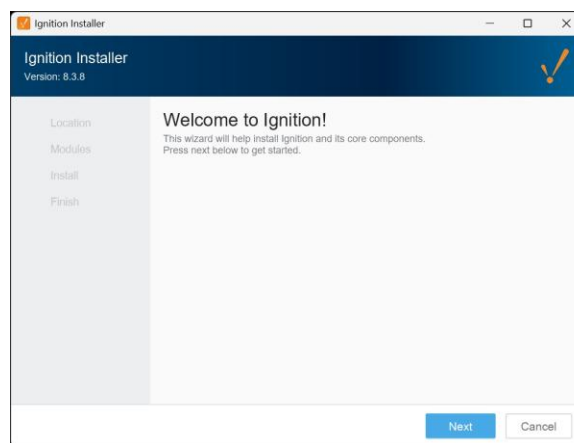


Figure 26. Ignition Installer.

Once installation starts, the page requires the location where Ignition will be installed and the gateway service name to be chosen. Choosing the default location is recommended, but the software should work fine if an alternative location and name are used.

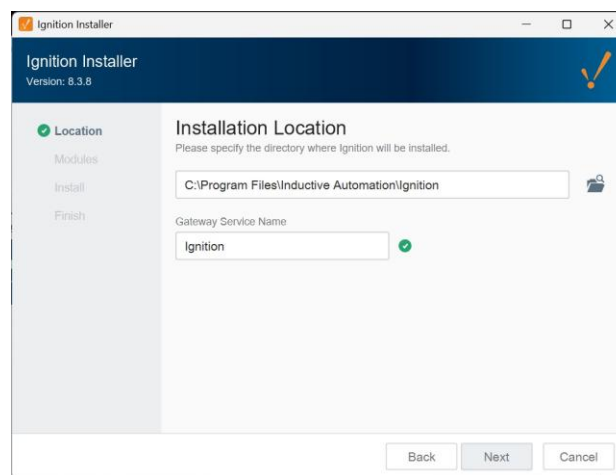


Figure 27. Ignition location.

After the location and name are chosen, the next page asks for a location to optionally restore from backup. You can choose the supplied gateway backup file provided with the install files as shown, but it can also be chosen later if necessary. Once the file is selected, choose *Next* to proceed (Figure 28.)

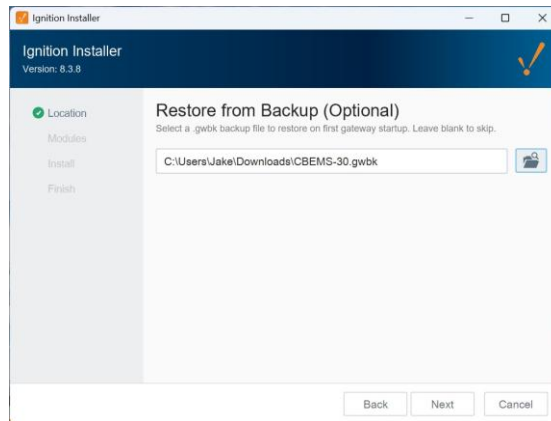


Figure 28. Restoring a gateway.

The next page asks for the installation options. Choosing the typical options on this page will install all the options required for CB-EMS (Figure 29). Press *Next* to proceed.

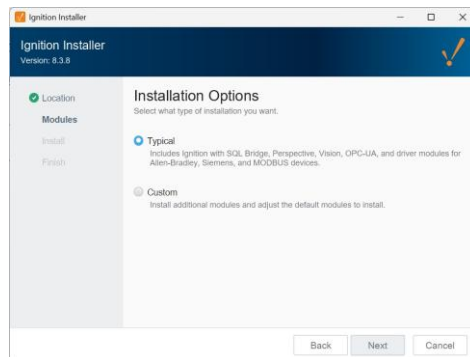


Figure 29. Installation options.

At this point, Ignition is ready to install, so choose *Install* to start the installation (Figure 30).

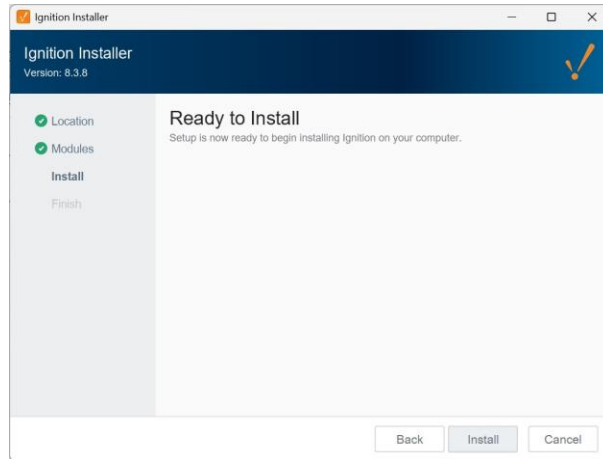


Figure 30. Ready to install.

Once the installation is finished, confirm that you want Ignition to start. This will bring up a web page that requires you to check the box acknowledging that you have read and agree to the license agreement. Press the button below the agreement to continue (Figure 31).

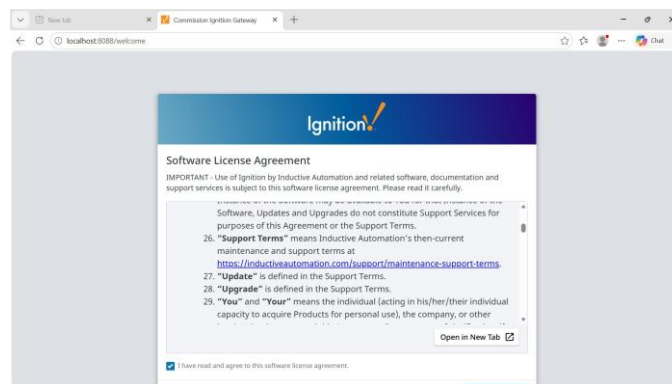


Figure 31. License agreement.

Finally, a screen will come up with a button to start and launch the gateway. Press that button to start the gateway (Figure 32).

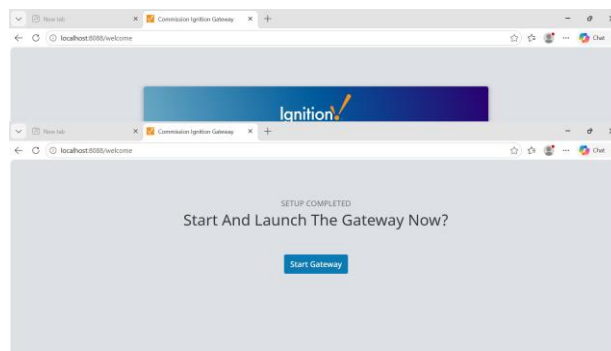


Figure 32. Launching the gateway.

Once the gateway starts after a minute or two, a prompt will ask whether to enable quick start. Choose not to use quick start since the gateway backup has the configuration.

Right-click on the Ignition service and press *Stop*. Next, double-click on Ignition and choose the *Log On* tab (Figure 36). On this tab, choose the *This Account* radio button and choose *Browse* to look for the svc_CBEMS account.

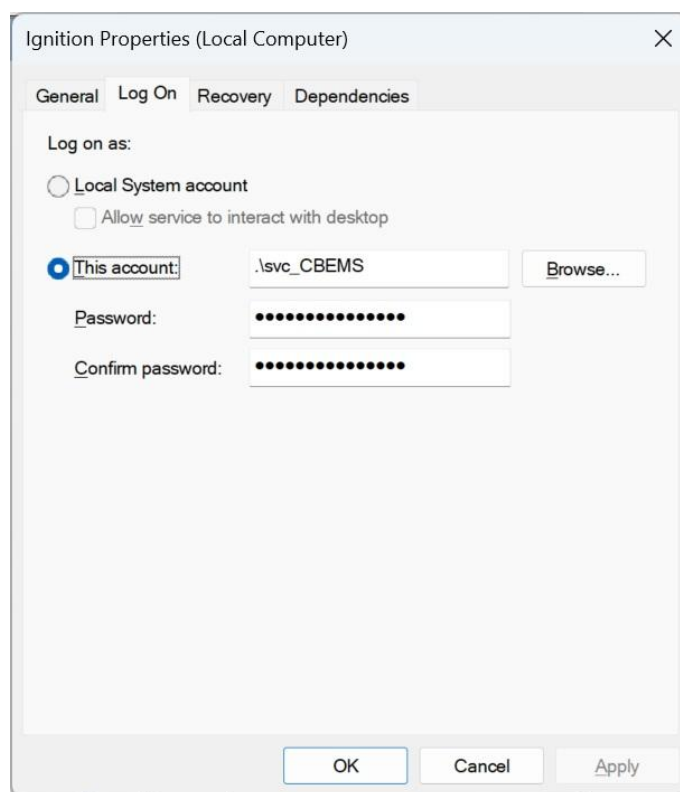


Figure 36. Logging into the service.

Once selected, type the password provided separately twice and choose *OK*. A message should pop up stating that svc_CBEMS has been granted the Log On As A Service right (Figure 37).

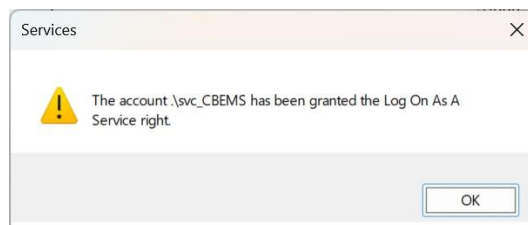


Figure 37. Granted log on right message.

With that done, right-click on the Ignition service in the services manager and verify that the service eventually shows as running.

Next, open the firewall application to add a rule to the firewall to allow remote connections to Ignition (Figure 38). By default, Windows uses MS Defender for the firewall software. These instructions show how to open a port using that software.

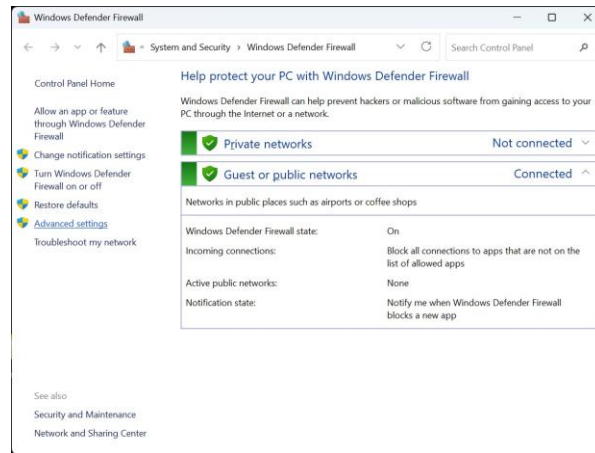


Figure 38. Windows Defender Firewall.

Select *Advanced Settings* on the Defender page and then select *Inbound Rules*. From that page, select *New Rule* (Figure 39).

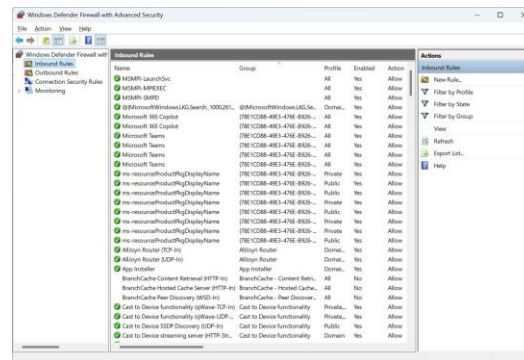


Figure 39. Inbound Rules in Windows Defender Firewall.

In the New Inbound Rule Wizard, select *Port* as the rule type to be used (Figure 40) and click *Next*.

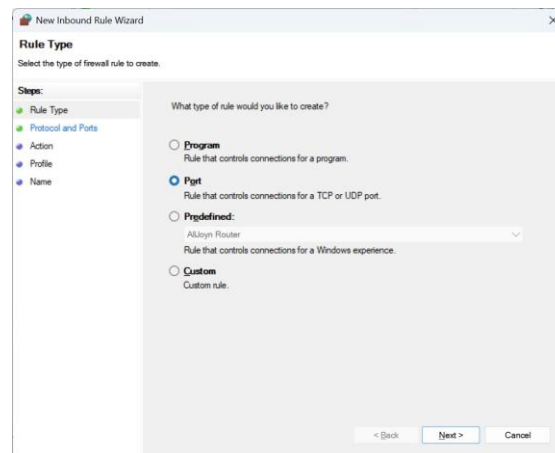


Figure 40. Rule type selection.

From this dialog box, choose the *TCP* radio button, choose *Specific local ports*, input 8088 for the port to be used (Figure 41), and click *Next*.

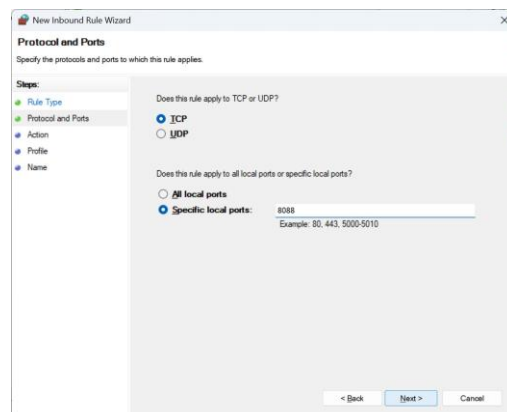


Figure 41. TCP port.

In the next dialog box, select *Domain*, *Private*, and *Public* (Figure 42) and choose *Next*.

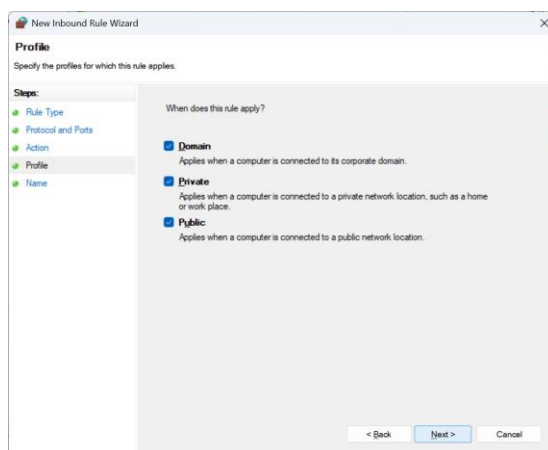


Figure 42. Profile dialog box.

Finally, a dialog box will open to name the new rule. Name the rule Ignition and put a comment that Ignition services CB-EMS.

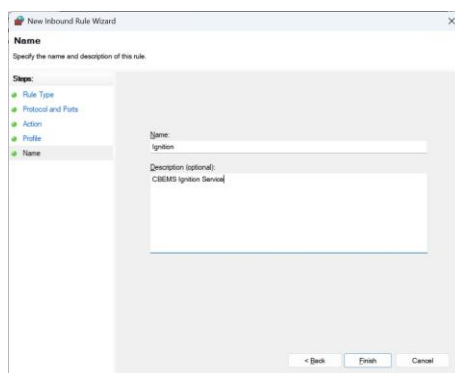


Figure 43. Naming the rule.

9.0 Finishing the Ignition Installation

9.1 Installing Ignition Designer and Vision Client Launcher

With all the components installed, Ignition Designer and Vision Client Launcher must be installed. Open a browser and type localhost:8088 in the address bar. From there, choose *login* at the top right and use the username and password provided separately (Figure 44).

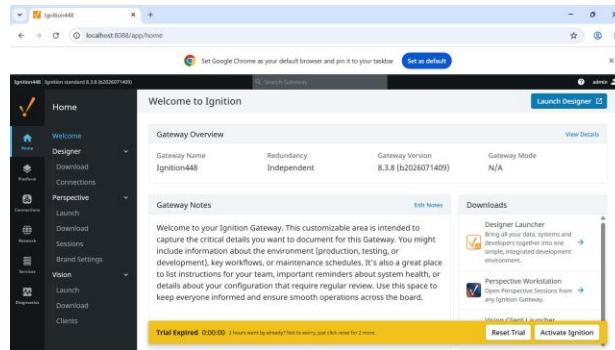


Figure 44. Ignition login.

Once logged in, choose the *Home* button in the left pane. In the next menu, expand *Designer* and choose *Download*. Press the *Download for Windows* button on the right to download Designer Launcher (Figure 45).

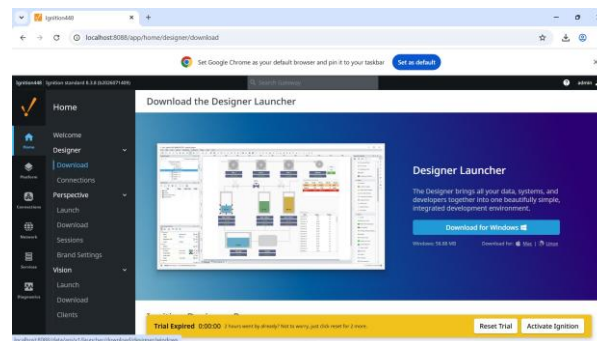


Figure 45. Download the Designer Launcher.

Once downloaded, run it and choose *Add Designer* from the middle of the window (Figure 46).

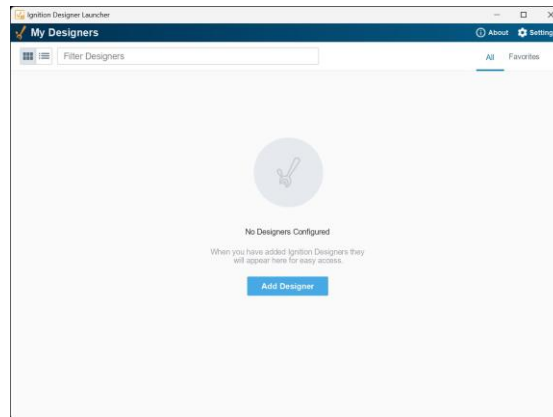


Figure 46. Designer Launcher.

When opened, it should automatically populate with the local installation of Ignition to connect to (Figure 47). Highlight the Ignition448 gateway and press *Add Designer*.

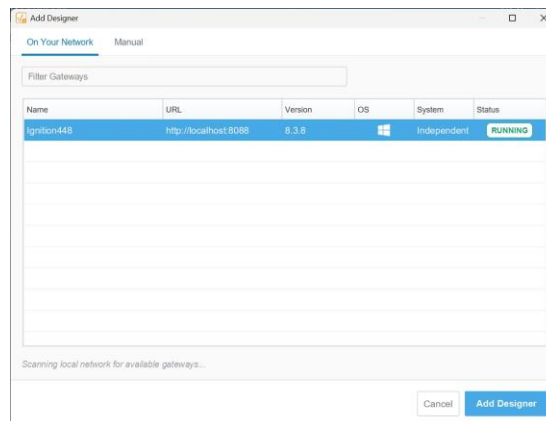


Figure 47. Add Designer dialog box.

This adds the link to Designer Launcher for CB-EMS. Note that Designer Launcher is a client software package that can be installed on any workstation that is networked to the system. CB-EMS is designed to not require the designer often, so it is not necessary to install it on a separate workstation.

Likewise, we need to download Vision Client Launcher to run the CB-EMS software. The process is similar and can be done from the web page where Designer Launcher was downloaded. To download the software, choose *Home* at the far left, then *Vision* and *Download*. From there, press the *Download for Windows* button (Figure 48).

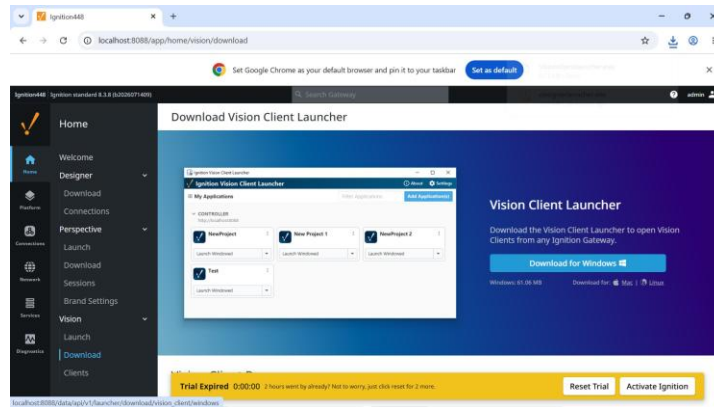


Figure 48. Vision Client Launcher download.

Run that application to install Vision Client Launcher on the server. During the install, choosing all the default options will allow the software to operate. Once open, choose *Add Application* (Figure 49).

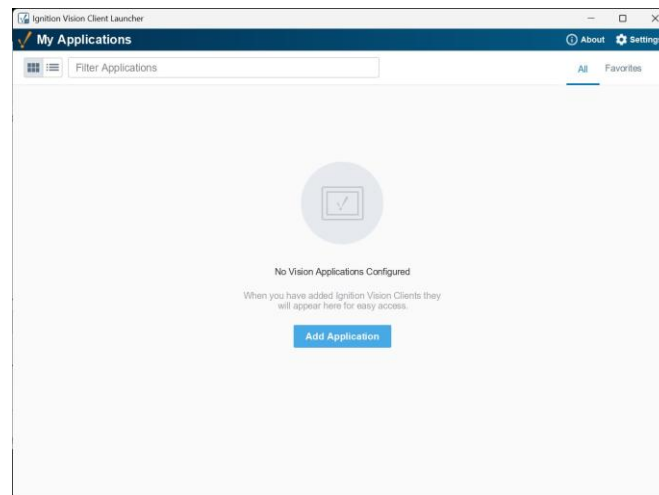


Figure 49. Vision Client Launcher.

As with Designer Launcher, the local host should come up, and you can select it and choose *Select Gateway* (Figure 50).

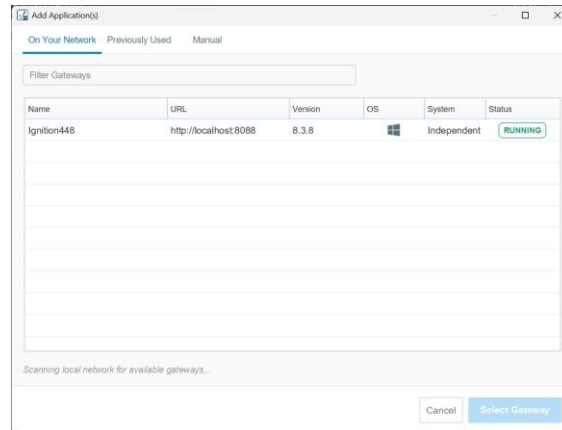


Figure 50. Selecting the client gateway.

Once the gateway has been selected, you can select the CBEMS_Site project from the list on that gateway. In the window that comes up next, you can select CBEMS_Site and press *Add Application(s)* (Figure 51).

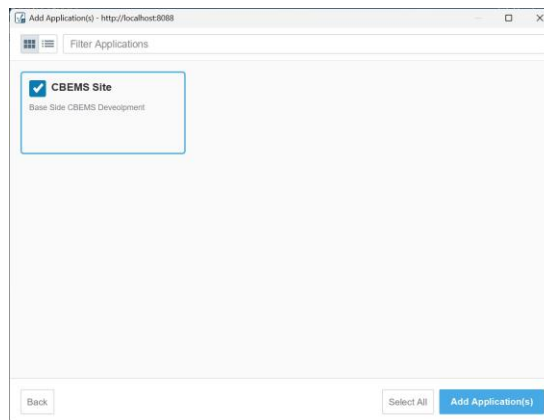


Figure 51. Adding an application.

Once it has been added to Vision Client Launcher, you can choose the three dots at the top of the link and choose *Create Desktop Shortcut* to put an icon on the desktop (Figure 52).

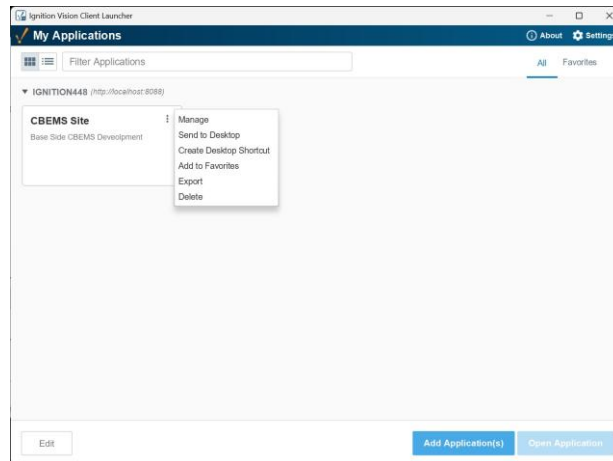


Figure 52. Adding a shortcut.

Once CB-EMS is installed with all its components, it's time to verify that the system is functioning properly. The first thing to verify is that the databases are connected to Ignition. To verify that the databases are connected properly, go to the Ignition web page that you used to install Designer Launcher and Vision, select Client Launcher, and select *Connections > Databases > Connections*. Verify that both CBEMS_dB and CBEMS_History are shown as valid (Figure 53).

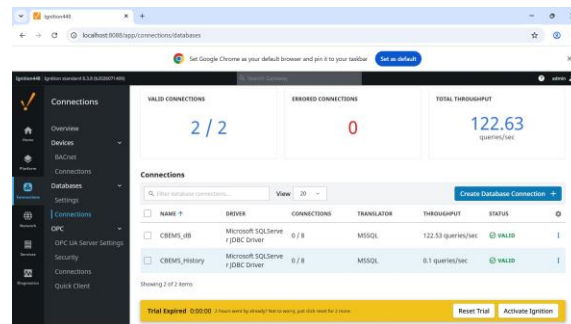


Figure 53. Ignition databases connected.

9.2 Final Setup and Checks

Once you have verified that CB-EMS is connected to the databases, there are a few values that need to be set up using Ignition Designer. Using Designer Launcher installed in Section 9.1, open Ignition Designer by clicking on *Open Designer* after selecting the *Ignition448* gateway (Figure 54).

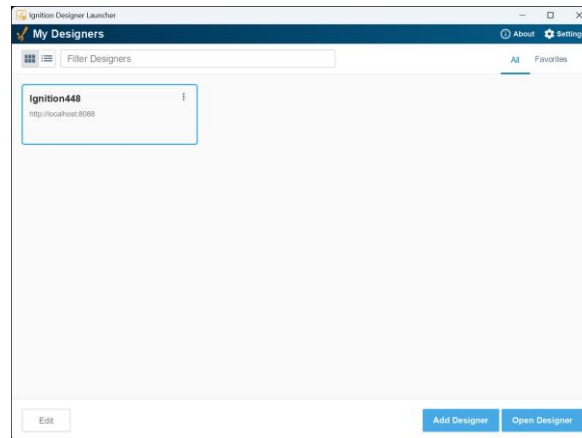


Figure 54. Opening a designer.

You will have to use the username and password provided elsewhere. Once the designer is opened, select the CBEMS_Site project and press **OPEN**. (Figure 55).

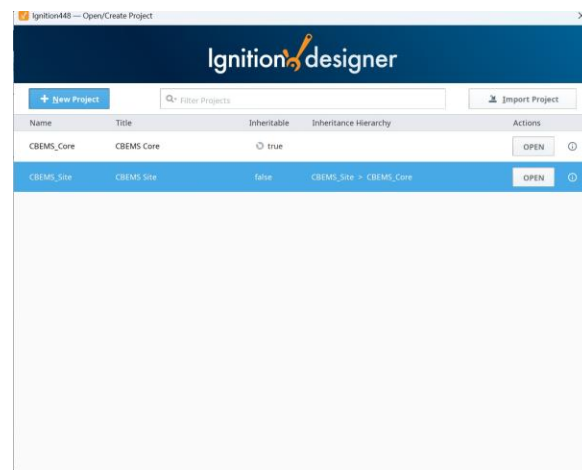


Figure 55. Opening a project.

With the CBEMS_Site project open, expand the *Vision* item in the project browser and the *Windows* item under *Vision* (Figure 56).

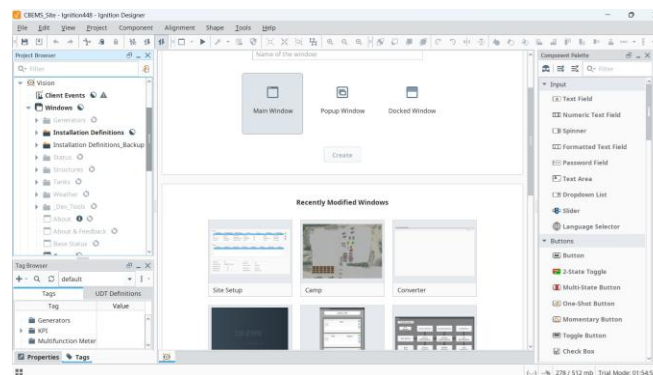


Figure 56. CBEMS_Site project.

From there, double-click on the *Site Setup* page to open it.

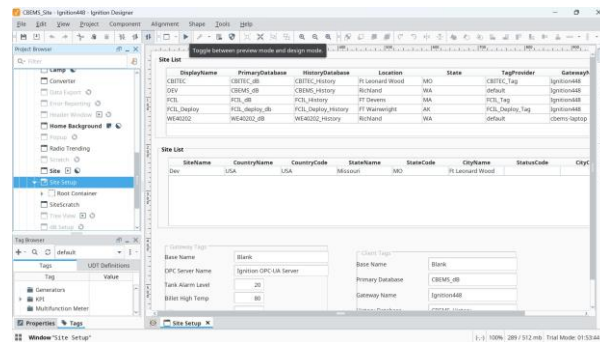


Figure 57. Site Setup page.

With the Site Setup page open, press the play button at the top of the screen to run the page. This will allow you to modify the site-specific database tables, gateway, and client tags (Figure 58).

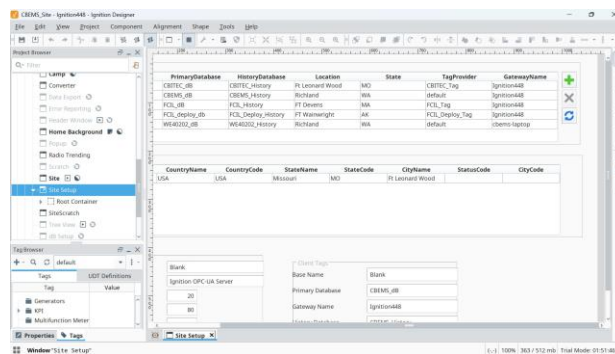


Figure 58. Site Setup running.

First, add the site to the ContingencyBases database table by pressing the green plus button at the top right of the screen. This will bring up a dialog box with all parameters to fill out (Figure 59). Fill out the site information and press *Add Site*. Once the site is added, close the dialog box with the red X at the top right corner. Note that if the site is already added, you can edit any of the parameters by editing this table.

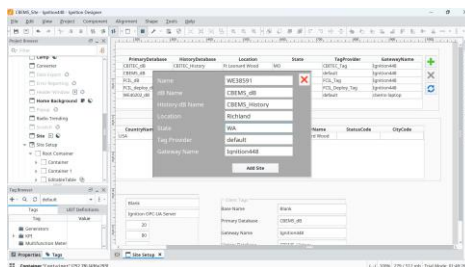


Figure 59. Adding a site to the base list.

Next, update the Site Location table by clicking on each field and updating accordingly (Figure 60). Each field in this table can be double-clicked to edit the value. Note the Site Name in this table should match the DisplayName from the site list. If this table is blank, a green plus sign button will appear and allow you to add the location information.

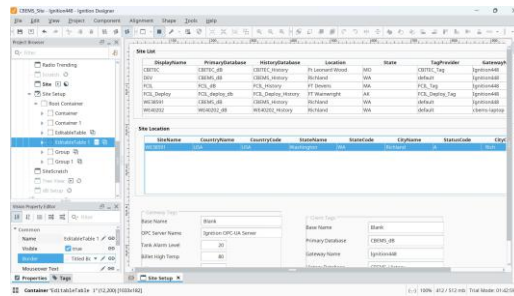


Figure 60. Editing a site location.

Finally, at the bottom of the screen, you can edit the client and gateway tags to finish setting up the gateway. The base name for both the gateway and client tags must match the site location SiteName and contingency base table DisplayName. The rest of the fields should stay as they are shown in Figure 60. There are special circumstances where these need to be changed, but they should be as shown for most installations.

10.0 Radio Signal Check Software

The radio signal check feature was added using a separate program to perform the SSH connection to the radio to obtain signal status information. That software is installed by copying the program to a specific directory on the server and also installing MS .NET version 8.0.

10.1 MS .NET Installation

Installing MS .NET 8.0 can be done by simply executing dotnet-runtime-8.0.26-win-x64.exe provided with the installation software and pressing *Install* (Figure 61).

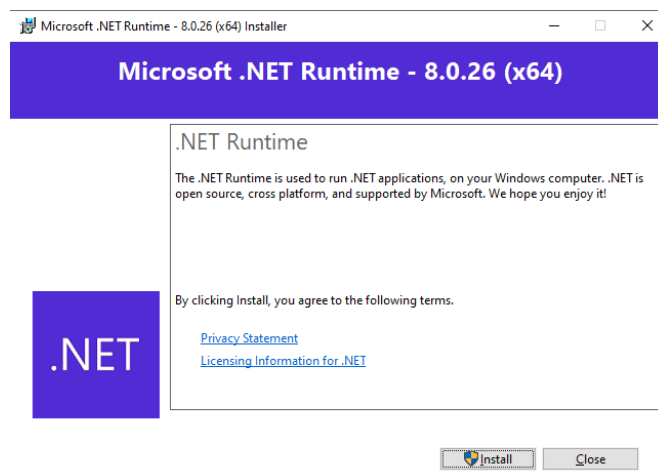


Figure 61. MS .NET installation.

10.2 SSHQuery Install

The SSHQuery program is executed from CB-EMS periodically to check the radio signal status. The results of the query are read by CB-EMS and stored in the database for analysis. To install the program, extract the files located in the SSHQuery.zip file into the C:\ directory. This can be done from Windows by right-clicking on the file and choosing *Extract* (Figure 62).

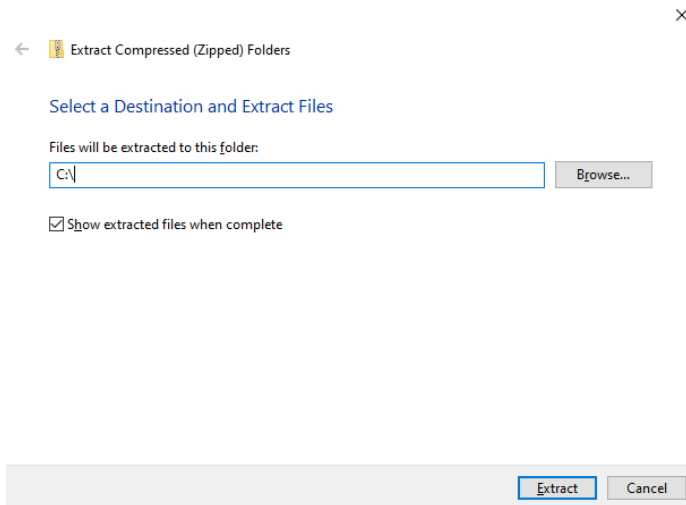


Figure 62. SSHQuery installation.

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