Evan McKenzie

Electrical Engineering Intern – RM1

Summer 2022

Background

- Computer Engineering Major at Michigan Technological University
- Graduating December 2022
- Originally from Lewiston, MI
- Enjoy golfing, broomball/hockey, backpacking, and film photography
- Worked Process Automation at Cleveland-Cliffs in summer 2021 before transitioning to Nucor

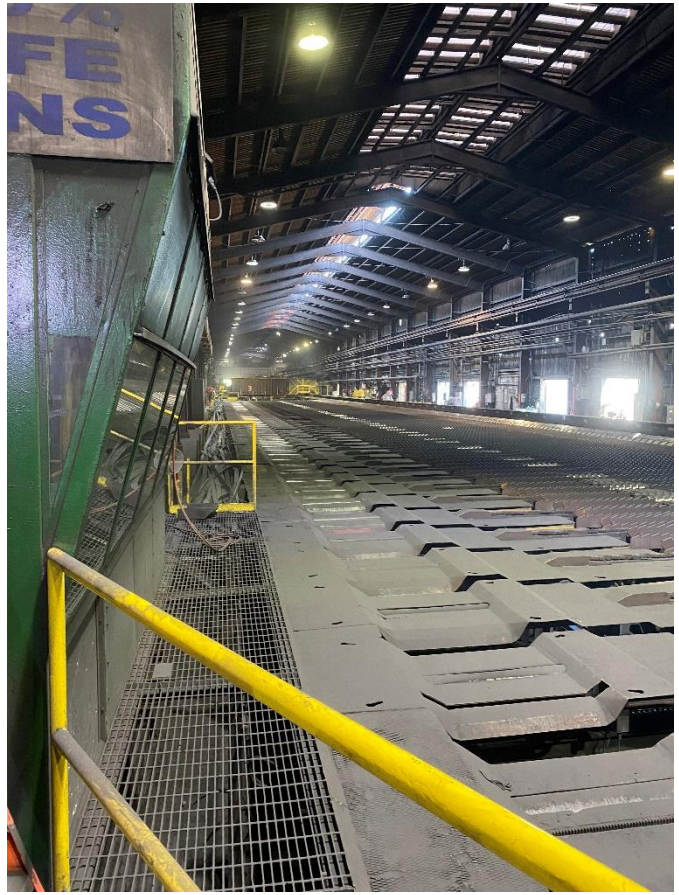
Michigan Tech

Summer Goals

- Become more familiar with electrical maintenance standard practices
- Spend more time hands-on in the mill
- Apply the theory based skills from college to a real world project
- Learn about Nucor as a whole

Getting Started

- Initially started the summer off following RM1 shift electricians around to get a feel for the mill
- Attended additional safety trainings (ladder safety, LOTO, etc.)
- Took basic PLC courses to learn the Rockwell software suite/PLC programming basics



Project 1: RM1 Electrical Shop PLC Trainer

- Goal: Build a PLC to allow RM1 electricians to become familiar with/get experience with PLC programming
- Isolated from the rest of the plant, safe to make mistakes and learn from them
- 1 AC Input, 1 AC Output, 1 DC Input, 1 DC Output cards to practice connecting and configuring different devices

Project 1 Current State and Next Steps

- Currently running in our electrical shop, needs three terminal blocks to have all cards operational but otherwise good to go

Project 2: CCL Sample Rack Measurement

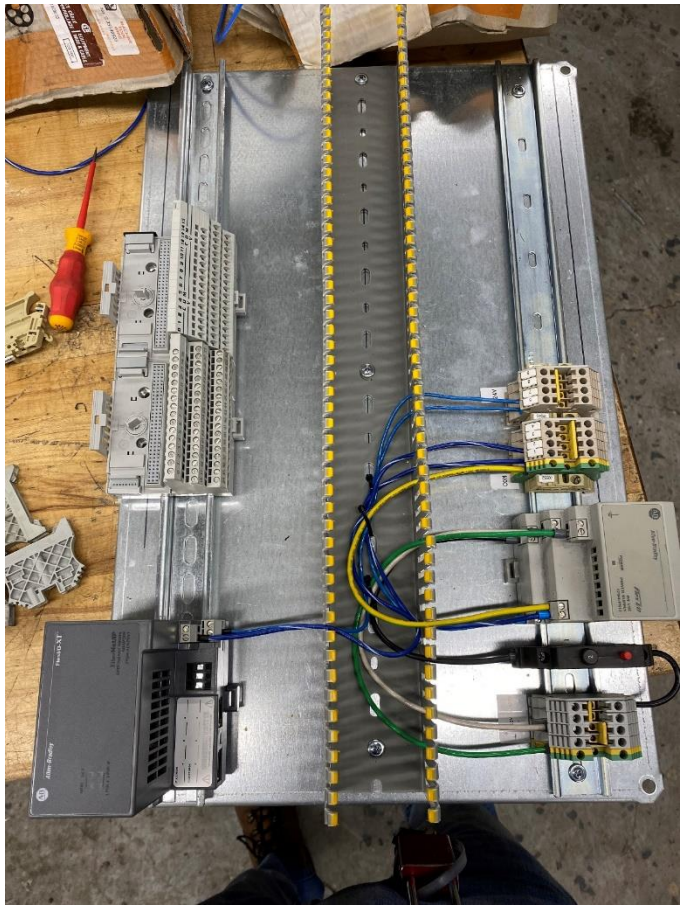
- Metallurgists want to measure the cooling rate of samples taken at CCL versus how bundles cool in the stack
- Build enclosure with Flex I/O and connect to stacker PLC
- Attach thermocouples to the outside of sample tubes to measure heat inside the tubes
- Add switches to determine when samples are added and removed from rack

Project 2 Goal and Scope

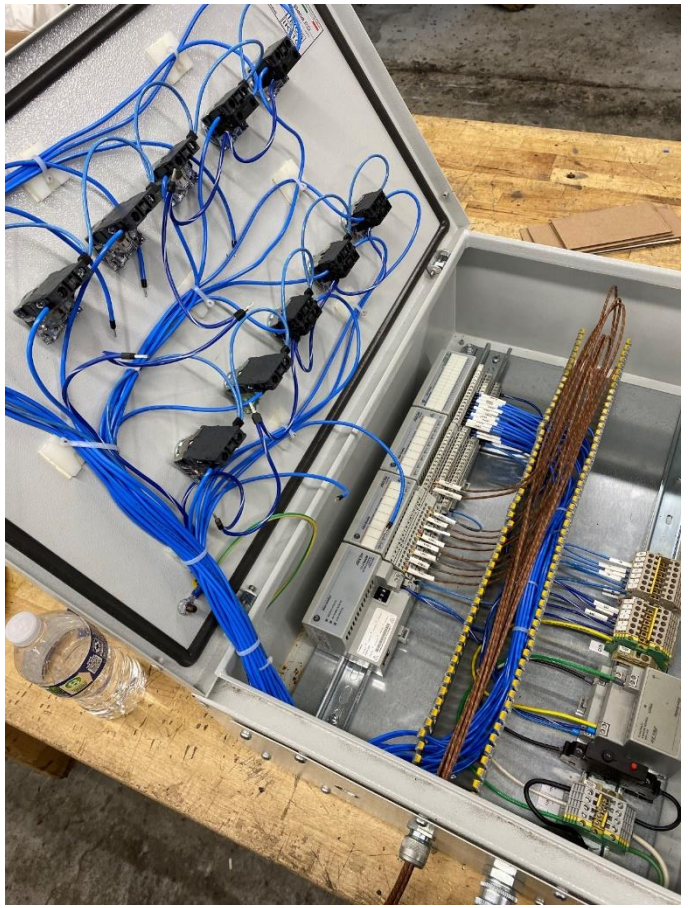
- Compare and contrast cooling rates and property differences between samples and finished product
- Have a historical record for different products to adjust properties
- Can also be connected to Test Lab HMI's for real time temp monitoring
- Eventually expand these measurements to angles as well

Project 2 Progression

Drilling holes for the switches



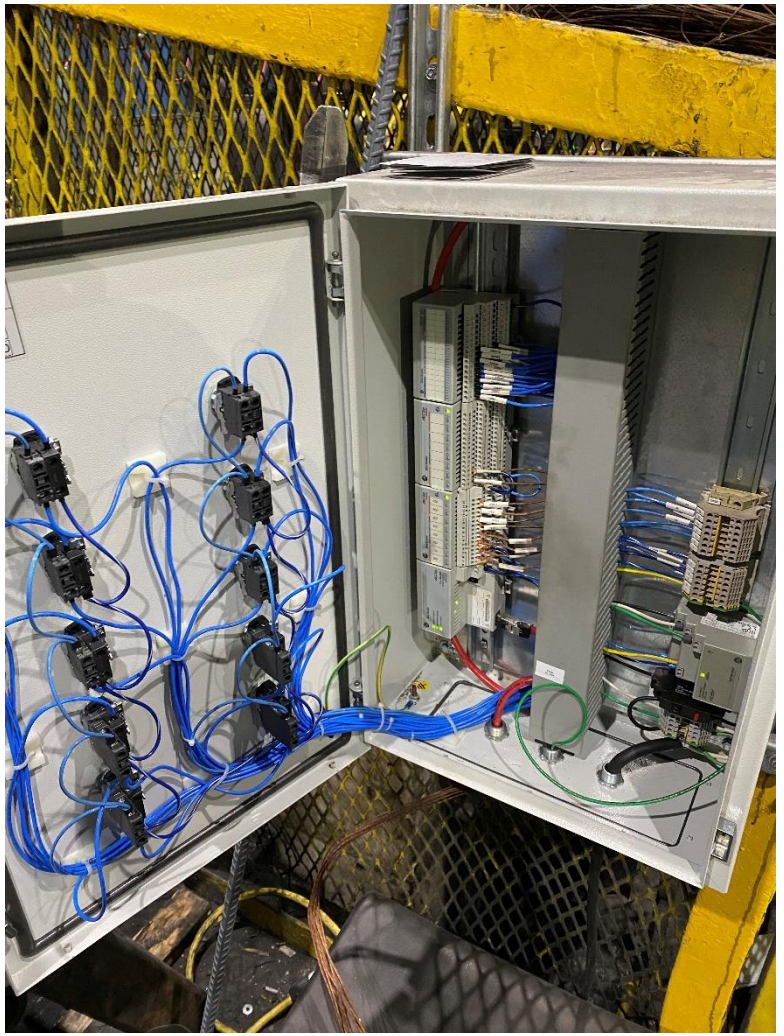
Ethernet and power supply wiring



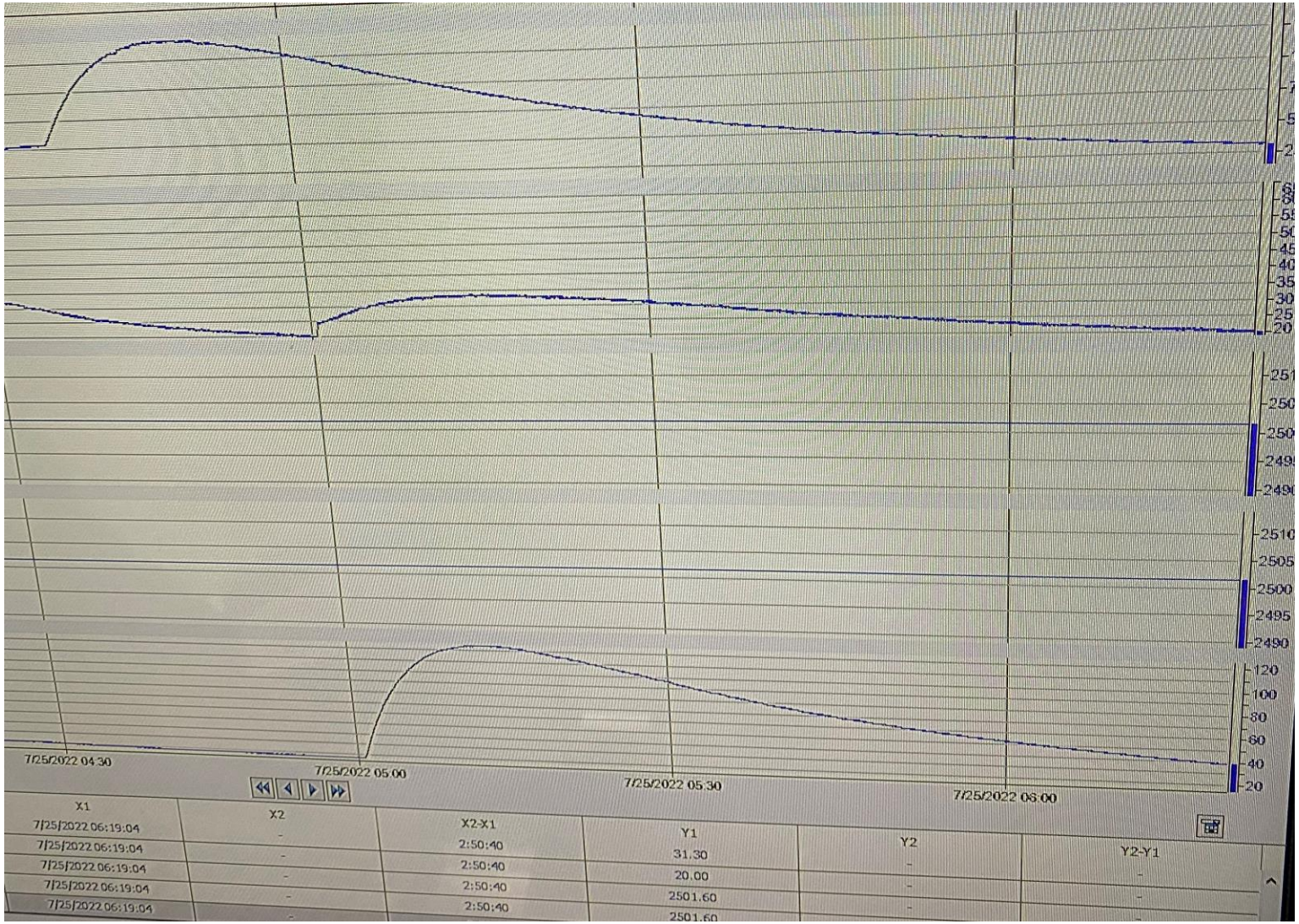
Connecting thermocouples and switch/LED combos

Project 2 Finalization

- Once everything was wired up inside the enclosure, Ethernet and power were ran to the box
- Switches light up when thrown, visual indicator of sample present



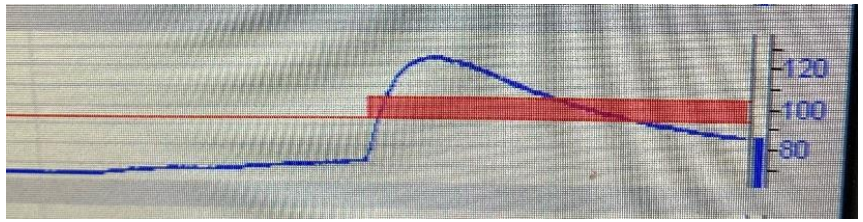
Project 2 Data

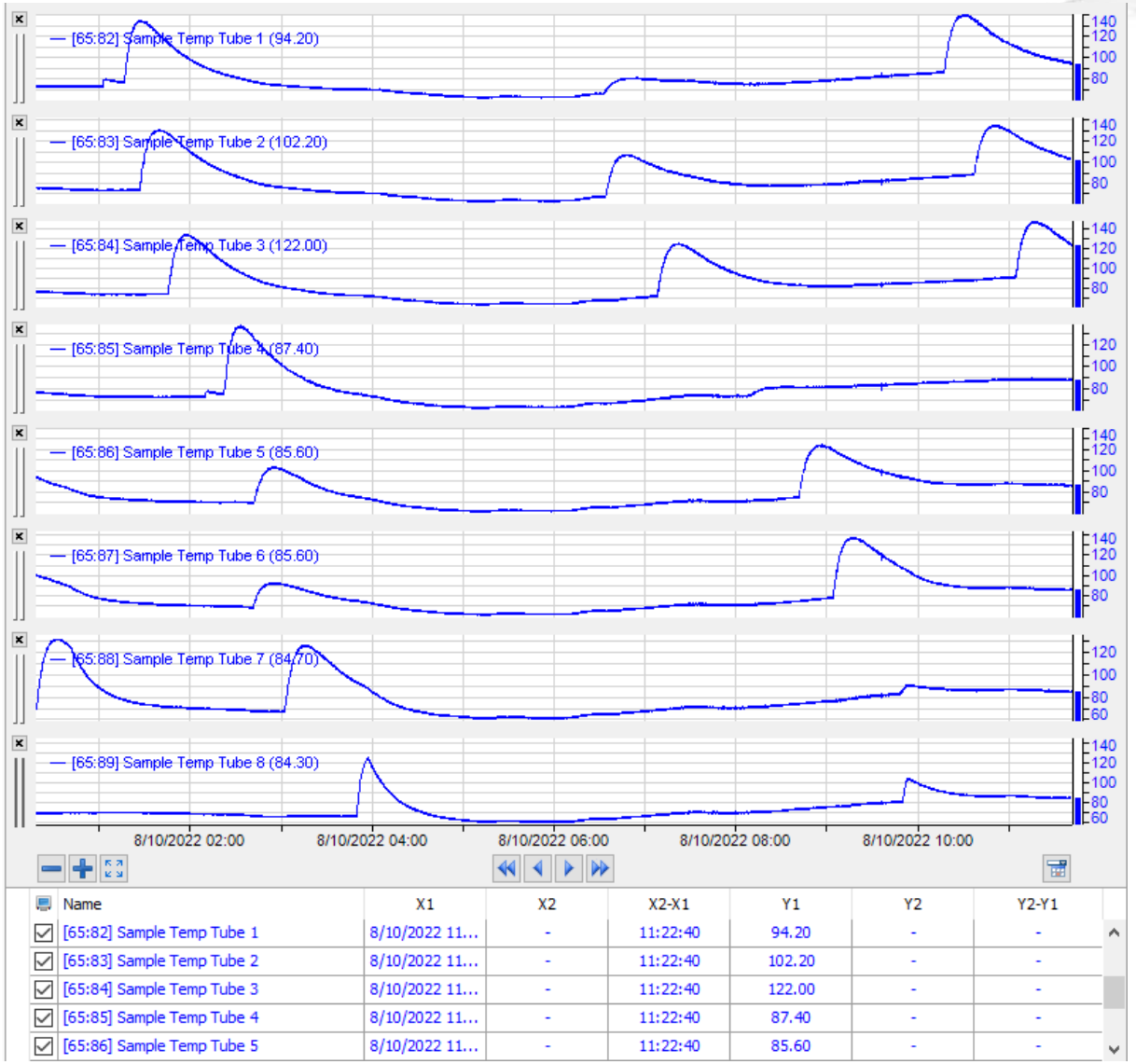


- Initial trend line for sample cooling
- Quick increase in heat followed by slow decrease as the sample cools down
- Switches necessary to see when tube is cooling back to ambient

Project 2 Data Continued

- Finalized trend lines for all connected tubes
- IBA tracking makes it easy to spot any samples with unusual properties
- 8/9/22 4-bar samples

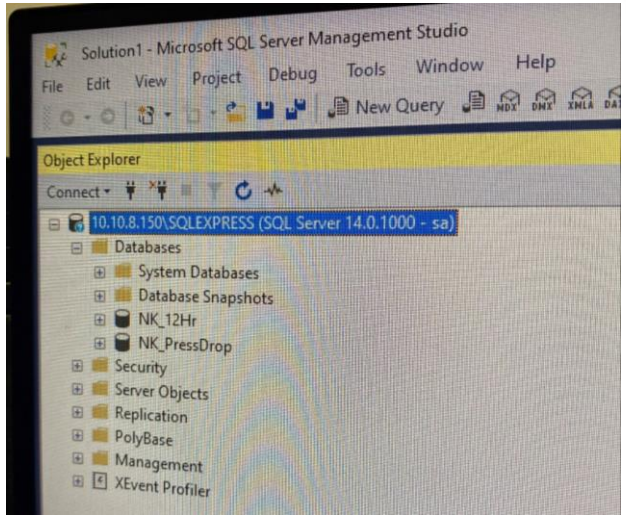


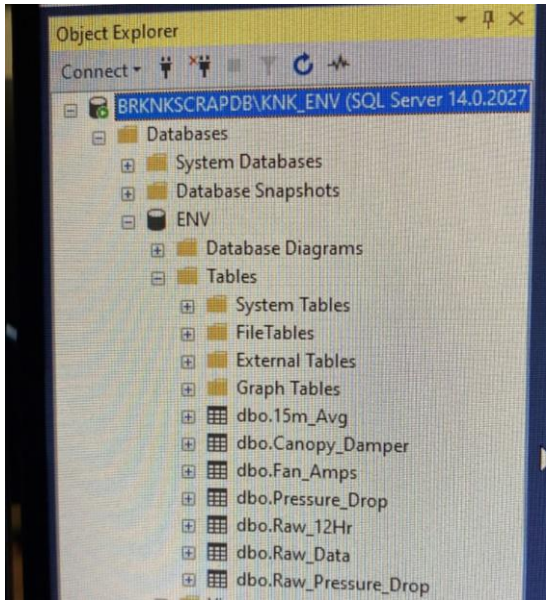


Name	X1	X2	X2-X1	Y1	Y2	Y2-Y1
[65:82] Sample Temp Tube 1	8/10/2022 11...	-	11:22:40	94.20	-	-
[65:83] Sample Temp Tube 2	8/10/2022 11...	-	11:22:40	102.20	-	-
[65:84] Sample Temp Tube 3	8/10/2022 11...	-	11:22:40	122.00	-	-
[65:85] Sample Temp Tube 4	8/10/2022 11...	-	11:22:40	87.40	-	-
[65:86] Sample Temp Tube 5	8/10/2022 11...	-	11:22:40	85.60	-	-

Project 3: Melt Shop Environmental Data Distribution

- The Environmental group needs data from the Melt Shop about certain parameters on the baghouse dampers, fan amps, and pressure drops
- Segregated networks between these two areas make it difficult to pass this information easily
- Two separate databases with similar information hosted on different networks





Project 3 Initial Solution

- Excel spreadsheet shared between ENV and IBA databases to import historical data
- Fixes to the Excel sheet's connection information brought it back online
- Issues: Manual, hosted on VM, and takes a long time to load data since we are pulling from 2018-present
- A better solution would be an automated system like the production emails

Project 3 Final Solution

- Windows Service/Scheduled Task that pulls data from SQL servers and emails that data on a weekly basis (Sunday 9PM)

```
public void EmailWeekly()
{
    // ------------------------------------------------------------------------------------------------------------------------------------------------------

    /* Connecting to SQL Servers and Retrieving Data
    *         - Create connection to both servers and databases
    *         - Execute created SQL statements
    *         - Confirm data recovery
    *         - Close connections and functions
    */

    //connection strings for IBA SQL Server
    string IBAconnString1 = @"Data Source = 10.10.8.150\SQLEXPRESS; Initial Catalog = NK_12Hr; MultipleActiveResultSets = True; Integrated Security = False
    string IBAconnString2 = @"Data Source = 10.10.8.150\SQLEXPRESS; Initial Catalog = NK_PressDrop; MultipleActiveResultSets = True; Integrated Security =

    SqlConnection ibaConn1 = new SqlConnection(IBAconnString1);            //SQLConnection
    SqlConnection ibaConn2 = new SqlConnection(IBAconnString2);            //SQLConnection

    //connection string for ENV SQL Server
    string ENVconnString = @"Data Source = 10.20.114.98\KNK_ENV; Initial Catalog = ENV; MultipleActiveResultSets = True; Integrated Security = False; Persi

    SqlConnection envConn = new SqlConnection(ENVconnString);            //SQLConnection

    string path = @"C:\errEmailPage.txt";

    try
    {
        using (ibaConn1)
        using(ibaConn2)
        using(envConn)
        {
            ibaConn1.Open();                    //open connection to IBA database
            ibaConn2.Open();
            envConn.Open();                    //open connection to ENV database

            string ibaSQLstring1 = "DECLARE @date DATETIME, @weekly DATETIME set @date = GETDATE() set @weekly = DATEADD(day, -7, CAST(GETDATE() AS date))
            string ibaSQLstring2 = "DECLARE @date DATETIME, @weekly DATETIME set @date = GETDATE() set @weekly = DATEADD(day, -7, CAST(GETDATE() AS date))
            string envSQLstring1 = "DECLARE @date DATETIME, @weekly DATETIME set @date = GETDATE() set @weekly = DATEADD(day, -7, CAST(GETDATE() AS date))
            string envSQLstring2 = "DECLARE @date DATETIME, @weekly DATETIME set @date = GETDATE() set @weekly = DATEADD(day, -7, CAST(GETDATE() AS date))
            string envSQLstring3 = "DECLARE @date DATETIME, @weekly DATETIME set @date = GETDATE() set @weekly = DATEADD(day, -7, CAST(GETDATE() AS date))

            SqlCommand ibaCom1 = new SqlCommand(ibaSQLstring1)
            {
                Connection = ibaConn1                        //link connection to command
            };
```

```
//
/* Email Data Formatting for Readability
*         - Create HTML outlines and table
*         - Add column headers from SQL table
*         - Format rows from SQL Reader into table cells
*         - Return a StringBuilder object with inline HTML
*/
public string CreateHtmlTableFormat(DataTable dt)
{
    string tab = "\t";

    StringBuilder sb = new StringBuilder();                //return object with inline formatting

    sb.AppendLine("<html>");
    sb.AppendLine(tab + "<body>");
    sb.AppendLine(tab + tab + "<table>");                    //HTML syntax settings
    sb.AppendLine(tab + tab + "<style> tr td:first-child {padding-left:0px;} td { padding: 00px 0px 0px 20px; } </style>");     //INLINE CSS for column spacing

    // headers.
    sb.Append(tab + tab + tab + "<tr>");

    foreach (DataColumn dc in dt.Columns)
    {
        sb.AppendFormat("<td>   {0}   </td>", dc.ColumnName);                //add column header titles
    }

    sb.AppendLine("</tr>");

    // data rows
    foreach (DataRow dr in dt.Rows)
    {
        sb.Append(tab + tab + tab + "<tr>");

        foreach (DataColumn dc in dt.Columns)
        {
            string cellValue = dr[dc] != null ? dr[dc].ToString() : "   ";            //add each cell of SQL table to HTML cell
            sb.AppendFormat("<td><center>  {0}  </center></td>", cellValue);            //center all data entries
        }

        sb.AppendLine("</tr>");
    }

    sb.AppendLine(tab + tab + "</table>");
    sb.AppendLine(tab + "</body>");
    sb.AppendLine("</html>");                    //close HTML syntax

    return sb.ToString();
}
```

Project 3 Data

Environmental Data for the Week Ending 8/1/2022

See data broken down by database

IBA Table 1 - 12Hr Averages

Timestamp	BH1_North_FA	BH1_South_FA	BH2_East_FA	BH2_West_FA	BH1_CC_Damper	BH1_SC_Damper	BH2_NC_Damper
8/1/2022 12:00:00 AM	225.002	225.001	160.223	160.201	59.6982	59.6048	77.6011
7/31/2022 12:00:00 PM	225	224.998	169.998	169.997	58.8588	58.8291	77.1719
7/31/2022 12:00:00 AM	225.001	225.001	170.004	170.003	61.1866	61.1151	78.4883
7/30/2022 12:00:00 PM	225.001	225.002	170	170.001	84.7739	84.7105	91.5702
7/30/2022 12:00:00 AM	223.118	223.12	169.994	169.992	73.3951	73.1643	85.2162
7/29/2022 12:00:00 PM	220.004	220.002	170.002	170.004	86.3888	86.1151	92.4661
7/29/2022 12:00:00 AM	219.998	219.999	170.001	170.001	61.2998	61.1952	78.4961
7/28/2022 12:00:00 PM	220.002	220.001	169.994	169.994	78.5834	78.3705	88.1499
7/28/2022 12:00:00 AM	220.005	220.004	170.008	170.01	84.2208	83.8581	91.2376
7/27/2022 12:00:00 PM	219.995	219.999	169.992	169.992	65.3244	65.2299	80.7575
7/27/2022 12:00:00 AM	220.005	220.003	170.008	170.006	59.6427	59.5775	77.6017
7/26/2022 12:00:00 PM	219.998	219.999	169.997	169.998	61.9402	61.8985	78.7094
7/26/2022 12:00:00 AM	220.001	220.001	170	170	86.9432	86.6015	91.8615
7/25/2022 12:00:00 PM	219.996	219.998	169.995	169.992	74.1713	74.0163	82.3838
7/25/2022 12:00:00 AM	220.005	220.003	170.008	170.007	73.0417	72.8829	80.7168

IBA Table 2 - Pressure Drop

Timestamp	BH1_15Avg	BH2_15Avg
8/1/2022 11:59:00 AM	8.46	0
8/1/2022 11:44:00 AM	8.55	0
8/1/2022 11:29:00 AM	8.56	0
8/1/2022 11:14:00 AM	8.3	1.62
8/1/2022 10:59:00 AM	8.02	6.48
8/1/2022 10:44:00 AM	7.97	6.47
8/1/2022 10:29:00 AM	7.91	6.38
8/1/2022 10:14:00 AM	7.89	6.41
8/1/2022 9:59:00 AM	7.9	6.41
8/1/2022 9:44:00 AM	7.94	6.33

ENV Table 1 - Canopy Damper

Timestamp	North_Canopy	Center_Canopy	South_Canopy
8/1/2022 1:15:00 AM	77	58	58
7/31/2022 1:15:00 PM	77	59	59
7/31/2022 1:15:00 AM	91	85	85
7/30/2022 1:15:00 PM	82	68	68
7/30/2022 1:15:00 AM	94	90	90
7/29/2022 1:15:00 PM	78	61	60
7/29/2022 1:15:00 AM	85	73	73
7/28/2022 1:15:00 PM	93	88	87
7/28/2022 1:15:00 AM	80	64	64
7/27/2022 1:15:00 PM	77	60	60
7/27/2022 1:15:00 AM	78	61	61
7/26/2022 1:15:00 PM	91	86	86
7/26/2022 1:15:00 AM	82	73	73
7/25/2022 1:15:00 PM	80	72	72
7/25/2022 1:15:00 AM	79	70	70

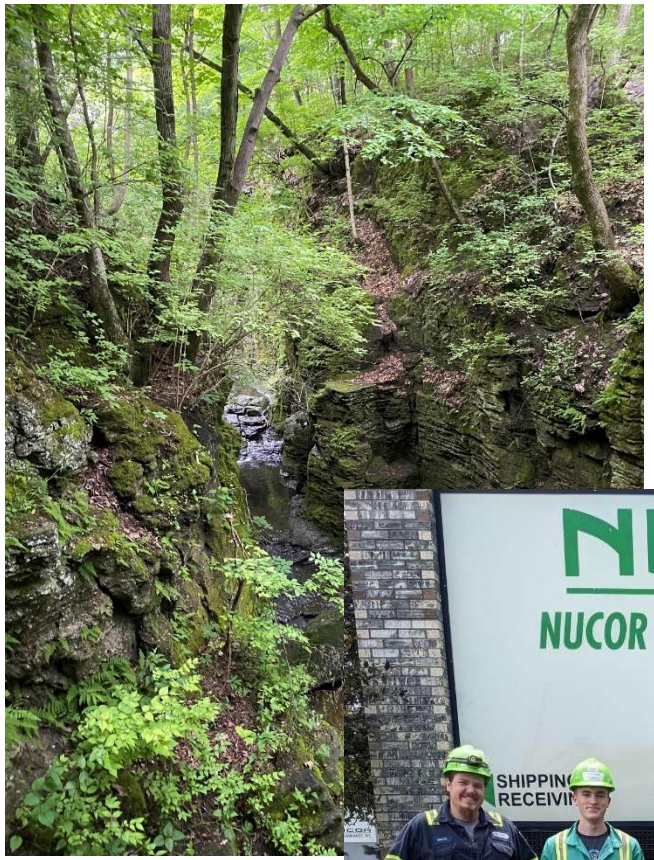
ENV Table 2 - Fan Amps

Timestamp	BH1_North	BH1_South	BH2_East	BH2_West
8/1/2022 1:15:00 AM	224	224	169	169
7/31/2022 1:15:00 PM	224	224	169	169
7/31/2022 1:15:00 AM	224	224	169	169
7/30/2022 1:15:00 PM	223	223	169	169

Helped With

- CCL Fan Removal/Camera Install
- Cooling Tower Pump Alarms
- Pump 5 Motor Replacement
- Compressor Room Conduit
- Melt Shop Network Troubleshooting

Outside of Work – Living our Culture



Biggest Takeaways

- Cannot compromise on safety
- A better understanding of production electrical maintenance and standard practices
- Increased automation experience, both software and hardware based
- Teamwork and good communication keeps us running

Special Thanks

- The Entire RM1 Electrical Team
- Mike Fritz
- Nick Hansen
- Jordan Turner and Alex Lopez
- My fellow interns

Questions?