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| --- |
| Predictive Health Notification  Alinity I Vacuum Sensor |
| ALINITY ci Immunoassay Analyzer  Anthony Schuler  June 25, 2018 |

**PHN - Alinity IA Vacuum Sensor Spec Sheet for Apollo**

**References**

D000041158/A-Alinity i Vacuum Pressure Sensor Prognostic Health Notification

**Summary**

To implement a Predictive Health Notification (PHN) for ALINITY i analyzers that will detect degrading vacuum sensor performance before the customer begins experiencing an increase in Error: 3304 ICQ System Vacuum Failure (Vacuum pressure too high).

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| --- | --- |
| PHN Descriptor | Alinity IA Vacuum Pressure Sensor |
| PHN Experience Code / Name | CCE3 PHN\_Alinity\_IA; PHN\_Vacuum\_IA; Sensor |
| PHN KM Article Number/ Name | K51814801 PHN Alinity IA: Vacuum Sensor |
| Skill Level | 2- Advanced Service |
| Always On Package | Always On 01DP5-01, 02, 03, 09, 70, 80, 83, 84, 89 |
| IDA Table | IDAQOWNER.ICQ\_VACUUMPRESSUREDATA |
| IDA Table Fields | MODULESN, VACUUMSTATENAME, LOGDATE\_LOCAL, ADCVALUE |
| Analysis Frequency | Daily |
| Data Required | Previous 1 day |
| Data Aggregation | Mean |
| Run Time Estimate | 2 seconds (1 day, 39 instruments, 12,050 rows, 1 algorithm flag) |
| Flag Criteria | Mean ADCVALUE <= 3,549 |
| Probable Failure Modes | Vacuum sensor |
| Suppression Experience Codes | None |
| Applicable Work Done Codes (WDC) | CW\* Fluid Movement, Vacuum Failure |

**Data Processing Steps**

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| Data Processing Steps | |
| 1 | Query all data from the previous day for each instrument (IDA Table: IDAQOWNER.ICQ\_VACUUMPRESSUREDATA). |
| 2 | Unique sensors will be identified by MODULESN. |
| 3 | Exclude sensors with less than 3 data points for the day. |
| 4 | Only include sensor data points where VACUUMSTATENAME = “VacuumBledOff”. |
| 5 | Summarize the data by calculating the mean ADCVALUE per instrument. |
| 6 | Flag any instrument where the mean ADCVALUE for its sensor is less than or equal 3,549. |

**APPENDIX 1:** CCE3 PHN Alinity IA: Vacuum Sensor

**Algorithm Code**

SELECT

evals.MODULESN

FROM

(SELECT

V.MODULESN,

AVG(V.ADCVALUE) AS MEAN\_ADC,

COUNT(V.ADCVALUE) AS NUM\_READINGS

FROM

IDAQOWNER.ICQ\_VACUUMPRESSUREDATA V

WHERE

TRUNC(V.LOGDATE\_LOCAL) >= TRUNC(SYSDATE) - 1

AND TRUNC(V.LOGDATE\_LOCAL) < TRUNC(SYSDATE)

AND V.VACUUMSTATENAME = 'VacuumBledOff'

GROUP BY

V.MODULESN

ORDER BY

V.MODULESN

) evals

WHERE

evals.MEAN\_ADC <= 3549

AND evals.NUM\_READINGS >= 3

**Apollo Algorithm Details**

(\* is Mandatory)

|  |  |
| --- | --- |
| **Apollo Details** |  |
| Algorithm ID \* | Alinity IA Vacuum Sensor |
| Algorithm Name \* | Alinity IA Vacuum Sensor |
| Algorithm Description \* | To detect degrading vacuum sensor performance before the customer begins experiencing an increase in Error: 3304 ICQ System Vacuum Failure (Vacuum pressure too high). |
| Product Family \* | Alinity IA |
| Algorithm Group \* | Alinity Waste |
| Functional Area | N/A |
| Algorithm Category 1 | N/A |
| Algorithm Category 2 | N/A |
| Algorithm Category 3 | N/A |
| Remaining Useful Life Value | 7 |
| Remaining Useful Life Unit | Day |
| Keep Results Num Days | 14 |
| **Routine Details** |  |
| Routine Source | Define New Routine |
| Routine Type | Oracle Procedure |
| Run Mode | Batch |
| Routine Invoke Command | PHM\_ICQ\_Vacuum\_Sensor\_PROC |
| Status | Enable |
| **ODS Routine Details** |  |
| ODS Routine Name | PHM\_ODS\_ICQ\_VACUUMPMDATA\_PROC |
| **Prognostic Health Notification Details** |  |
| PHN Code | PHN\_Alinity IA\_CCE3 |
| Issue Description (Use Algorithm Name) |  |
| Experience Code | CCE3 |
| **Knowledge Management DB Articles** |  |
| KM Article ID | K51814801 |
| KM Article | PHN Alinity IA: Vacuum Sensor |
| **Parameters** |  |
| Parameter Group Name | ICQ\_ICQ\_Vacuum\_Sensor |
| **Parameter Name** | **Parameter Values** |
| IHN\_LEVEL3\_DESC | Alinity IA Vacuum Sensor |
| I\_VACUUM\_MEANADC\_MIN | 3549 |
| I\_VACUUM\_VACSTNAME | VacuumBledOff |
| THRESHOLDS\_COUNT | 1 |
| THRESHOLD DESCRIPTION | Alinity IA Vacuum Sensor |
| **Chart Details** |  |
| Chart Title | Alinity IA Vacuum Sensor |
| Chart Type | Line Chart |
| Chart Threshold Parameter | ICQ DARKCOUNT – Thresholds\_Count |
| Group ID | Group 7 |
| Chart X Axis Name | Date |
| Chart Y Axis Name | Threshold Count |

**APPENDIX 2:** Algorithm Understanding Check – Algorithm Developer to Predictive Health Monitoring (PHM) Specialist Transition

**Data Set Description**

The data set for this understanding check was retrieved from the ICQOWNER.ODR\_PMEVENTSICQ table within the BSQD1I database. Data was collected for all instruments between December, 1 2016 and February 28, 2017, inclusive. Data collection was limited to the MODULESN, LOGDATE, VACUUMSTATENAME, and ADCVALUE fields.

**Data Set Retrieval**

The following SQL code was used to retrieve the data set:

SELECT

V.MODULESN,

V.LOGDATE,

V.VACUUMSTATENAME,

V.ADCVALUE

FROM

ICQOWNER.ODR\_VACUUMPRESSUREDATAICQ V

WHERE

TRUNC(V.LOGDATE) >= TO\_DATE('12/01/2016 12:00:00 AM', 'mm/dd/yyyy hh:mi:ss am')

AND TRUNC(V.LOGDATE) < TO\_DATE('03/01/2017 12:00:00 AM', 'mm/dd/yyyy hh:mi:ss am')

**Algorithm Developer Analysis**

The following analysis steps, using JMP, were performed by the Algorithm Developer to analyze the data set and flag algorithm violations:

* Queried vac table for all data in the “vacuumbledoff” state from 12/1/2016 and 2/28/2017.

New SQL Query(

       Version( 130 ),

       Connection(

              "ODBC:DSN=BSQD1I;UID=towerjx;PWD=%\_PWD\_%;DBQ=BSQD1I;DBA=W;APA=T;EXC=F;FEN=T;QTO=T;FRC=10;FDL=10;LOB=T;RST=T;BTD=F;BNF=F;BAM=IfAllSuccessful;NUM=NLS;DPM=F;MTS=T;MDI=F;CSR=F;FWC=F;FBS=64000;TLO=O;MLD=0;ODA=F;"

       ),

       QueryName( "ODR\_VACUUMPRESSUREDATAICQ" ),

       Select(

              Column( "DEVICEID", "t1" ),

              Column( "MODULESNDRM", "t1" ),

              Column( "MODULEID", "t1" ),

              Column( "MODULESN", "t1" ),

              Column( "PRIMARYKEY", "t1" ),

              Column( "LOGDATE", "t1", Numeric Format( "m/d/y h:m:s", "0", "NO", "" ) ),

              Column( "INSTRUMENTID", "t1" ),

              Column( "VACUUMSTATE", "t1" ),

              Column( "VACUUMSTATENAME", "t1" ),

              Column( "VERIFYVACUUMSUBSTATE", "t1" ),

              Column( "VERIFYVACUUMSUBSTATENAME", "t1" ),

              Column( "ADCVALUE", "t1" ),

              Column( "PSIGVALUE", "t1" ),

              Column( "ERRORCODE", "t1" ),

              Column( "CONTROLLERLOCATION", "t1" ),

              Column( "CONTROLLERLOCATIONNAME", "t1" ),

              Column( "FILEID", "t1" ),

              Column( "LOADDATE", "t1", Numeric Format( "m/d/y h:m:s", "0", "NO", "" ) ),

              Column( "ADCVALUELEAKTEST", "t1" ),

              Column( "PSIGVALUELEAKTEST", "t1" ),

              Column( "BLEDMAXLEVEL", "t1" ),

              Column( "BLEDMINLEVEL", "t1" ),

              Column( "MINIMUMBASELINEPRESSURE", "t1" ),

              Column( "MINIMUMPRESSURE", "t1" ),

              Column( "VACUUMPUMPOUTPUT", "t1" ),

              Column( "ERRORMESSAGE", "t1" ),

              Column( "VACUUMMUCHTOOHIGH", "t1" ),

              Column( "WASTEPUMPTHRESHOLD", "t1" ),

              Column( "VACUUMPUMPTHRESHOLD", "t1" ),

              Column( "LEAKTESTMAXIMUM", "t1" )

       ),

       From(

              Table( "ODR\_VACUUMPRESSUREDATAICQ", Schema( "ICQOWNER" ), Alias( "t1" ) )

       ),

       Where(

              In List(

                     Column( "VACUUMSTATENAME", "t1" ),

                     {"VacuumBledOff"},

                     UI( SelectListFilter( ListBox, Base( "Categorical" ) ) )

              ) & Between(

                     Column(

                           "LOGDATE",

                           "t1",

                           Numeric Format( "m/d/y h:m:s", "0", "NO", "" )

                     ),

                     Bounds( 3563395200, 1, 3571171200, 1 ),

                     UI( Range( Base( "Continuous" ) ) )

              )

       )

) << Modify

* Created a summary table by Modulesn/date with the daily mean ADCvalue.

Data Table( "ODR\_VACUUMPRESSUREDATAICQ" ) << Summary(

       Group( :Name( "Date[LOGDATE]" ), :MODULESNDRM, :MODULESN ),

       Mean( :ADCVALUE ),

       Freq( "None" ),

       Weight( "None" )

)

* Selected rows less than or equal to the 3549 value (excluding days with less than 3 data points).
* 28 flags on SCM00193/QC00148 were detected.

**PHM Specialist Analysis**

The following SQL code was used by the PHM Specialist to analyze the data set and flag algorithm violations:

SELECT

evals.MODULESN,

evals.DAY,

evals.MEAN\_ADC,

evals.NUM\_READINGS

FROM

(SELECT

V.MODULESN,

TRUNC(V.LOGDATE) AS DAY,

AVG(V.ADCVALUE) AS MEAN\_ADC,

COUNT(V.ADCVALUE) AS NUM\_READINGS

FROM

ICQOWNER.ODR\_VACUUMPRESSUREDATAICQ V

WHERE

TRUNC(V.LOGDATE) >= TO\_DATE('12/01/2016 12:00:00 AM', 'mm/dd/yyyy hh:mi:ss am')

AND TRUNC(V.LOGDATE) < TO\_DATE('03/01/2017 12:00:00 AM', 'mm/dd/yyyy hh:mi:ss am')

AND V.VACUUMSTATENAME = 'VacuumBledOff'

GROUP BY

V.MODULESN,

TRUNC(V.LOGDATE)

ORDER BY

V.MODULESN,

TRUNC(V.LOGDATE)

) evals

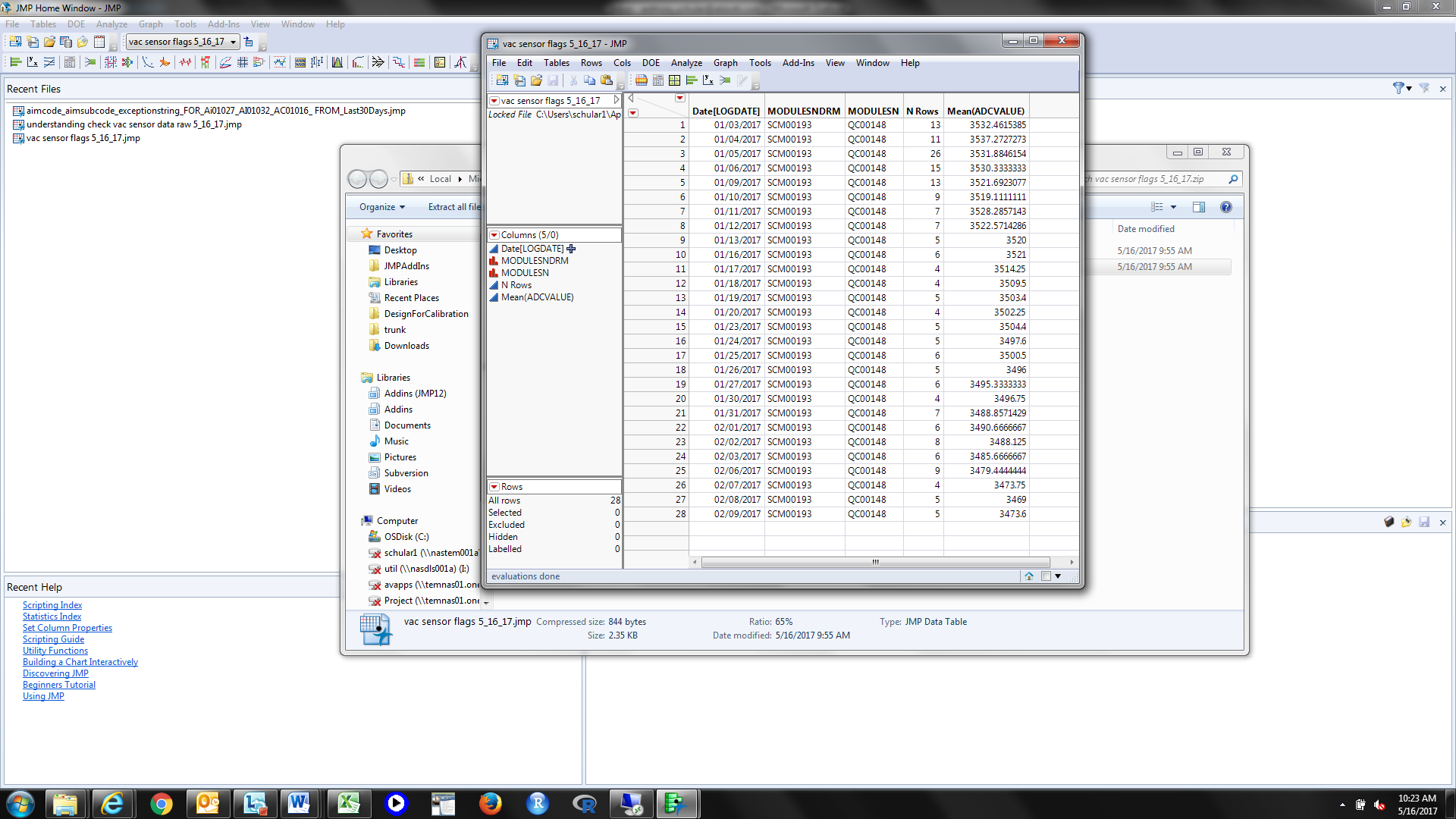
WHERE

evals.MEAN\_ADC <= 3549

AND evals.NUM\_READINGS >= 3

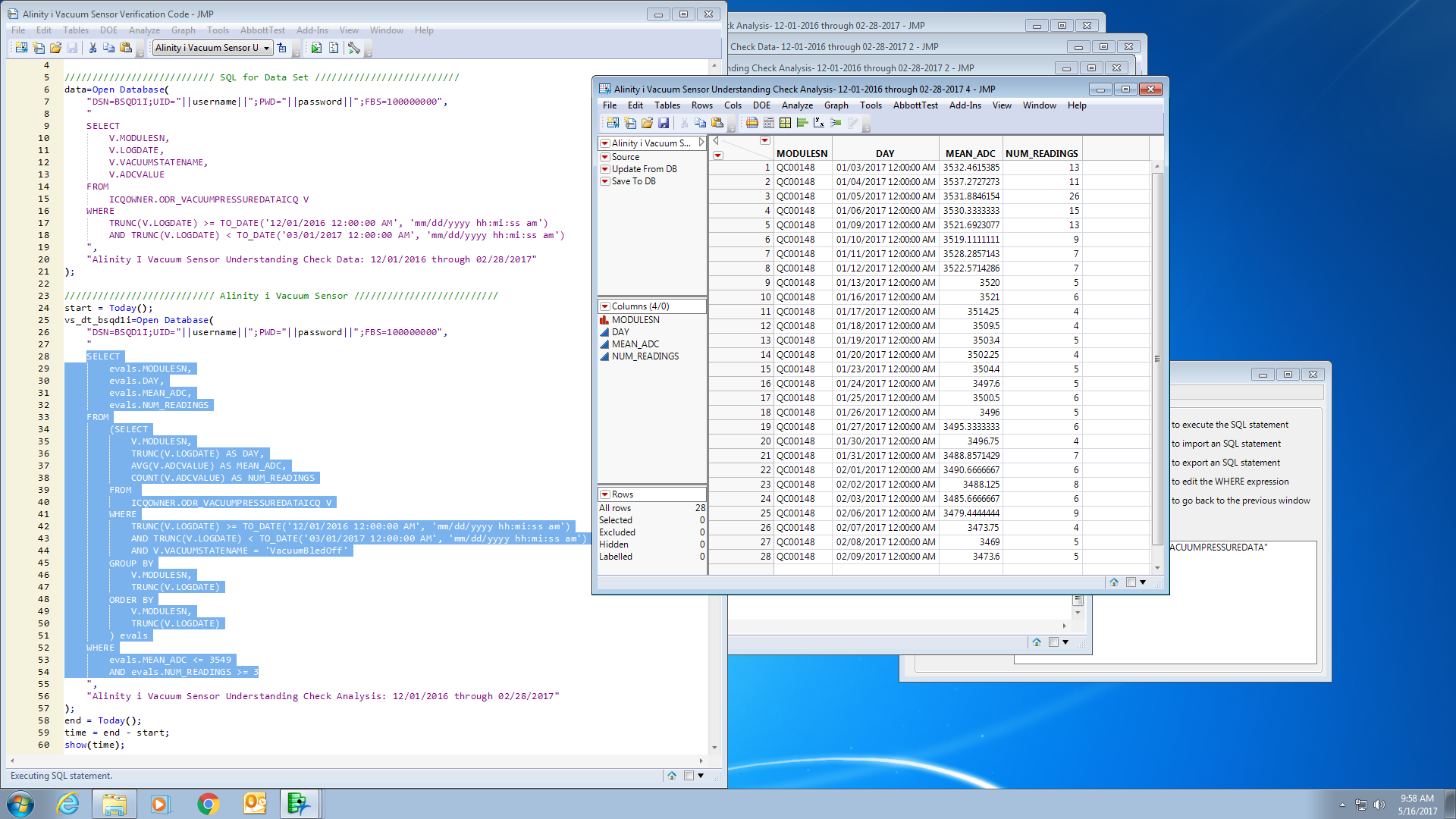
**Algorithm Developer Analysis Output**

The following 28 instruments (MODULESN) were identified as violating the algorithm by the Algorithm Developer:



**PHM Specialist Analysis Output**

The following 28 instruments (MODULESN) were identified as violating the algorithm by the PHM Specialist:



**Algorithm Developer & PHM Specialist Output Comparison**

|  |  |  |  |
| --- | --- | --- | --- |
| Total # of Unique Instrument-Days Tested | Total # of Algorithm Developer Flags | Total # of PHM Specialist Flags | Total # of Matched Flags (Algorithm Developer vs. PHM Specialist) |
| **2,645** | **28** | **28** | **28** |

**Understanding Check Summary**

Based on the outputs from both the Algorithm Developer and PHM Specialist, the PHM Specialist’s understanding of the delivered algorithm is confirmed. Both the Algorithm Developer and PHM Specialist analyzed the same data set and got the same results. In particular, the MODULESN and Date[LOGDATE]/DAY fields matched for all 28 instrument-day (MODULESN-Date[LOGDATE]/DAY) combinations. This means that both the Algorithm Developer and PHM Specialist flagged the same 28 algorithm violations within the given data set. Furthermore, there were no mismatches between the output from the Algorithm Developer and the output from the PHM Specialist.

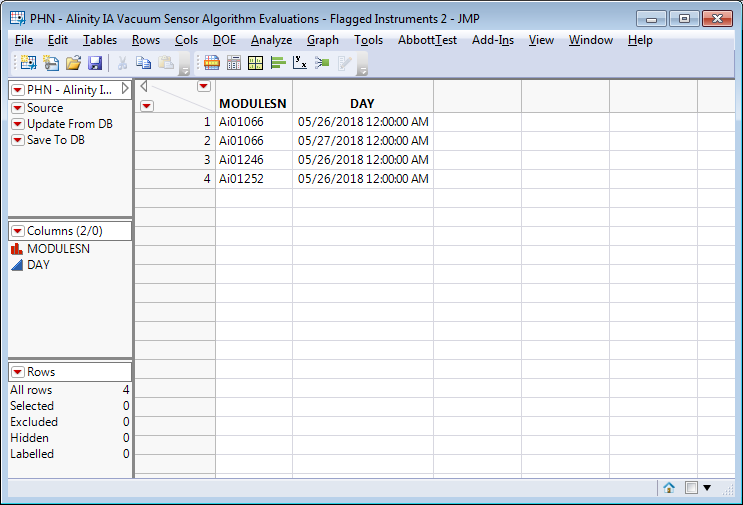
**APPENDIX 3:** Algorithm Transition to Apollo – PHM Specialist to Apollo Developer

**Data Set Description**

The data set for this transition was retrieved from the IDAQOWNER.ICQ\_VACUUMPRESSUREDATA table within the DABBTO database. Data was collected for all available instruments between May, 25 2018 and May 26, 2018, inclusive.

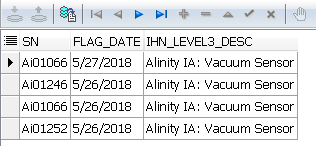
**PHM Specialist Analysis Output**

The following 4 instrument-days (MODULESN-DAY) were identified as violating the algorithm by the PHM Specialist:



**Apollo Developer Analysis Output**

The following 4 instrument-days (SN-FLAG\_DATE) were identified as violating the algorithm by the Apollo Developer:



**Algorithm Transition Summary**

Based on the outputs from both the Apollo Developer and PHM Specialist, the Apollo Developer’s understanding of the delivered algorithm is confirmed. Both the Apollo Developer and PHM Specialist analyzed the same data set and got the same results. In particular, the MODULESN/SN and DAY/FLAG\_DATE fields matched. This means that both the Apollo Developer and PHM Specialist flagged the same algorithm violations within the given data set.