CHAPTER 4 RESEARCH OUTCOMES - FAILURE ANALYSIS

The purpose of this chapter is to indicate the outcomes of the action research processes that were followed in Chapter 3. The design processes that were employed are presented in this chapter. The outcomes of the action research included the creation of plant assets in the interface and the configuration of symptoms and faults according to the symptoms and fault model. In addition this chapter will discuss the establishment of a relationship between symptoms and particular faults in order to create a fault tree for each configured asset.

Failure analysis is indicated in stage two of the SAMI model as highlighted in the blue block in Figure 17 below.

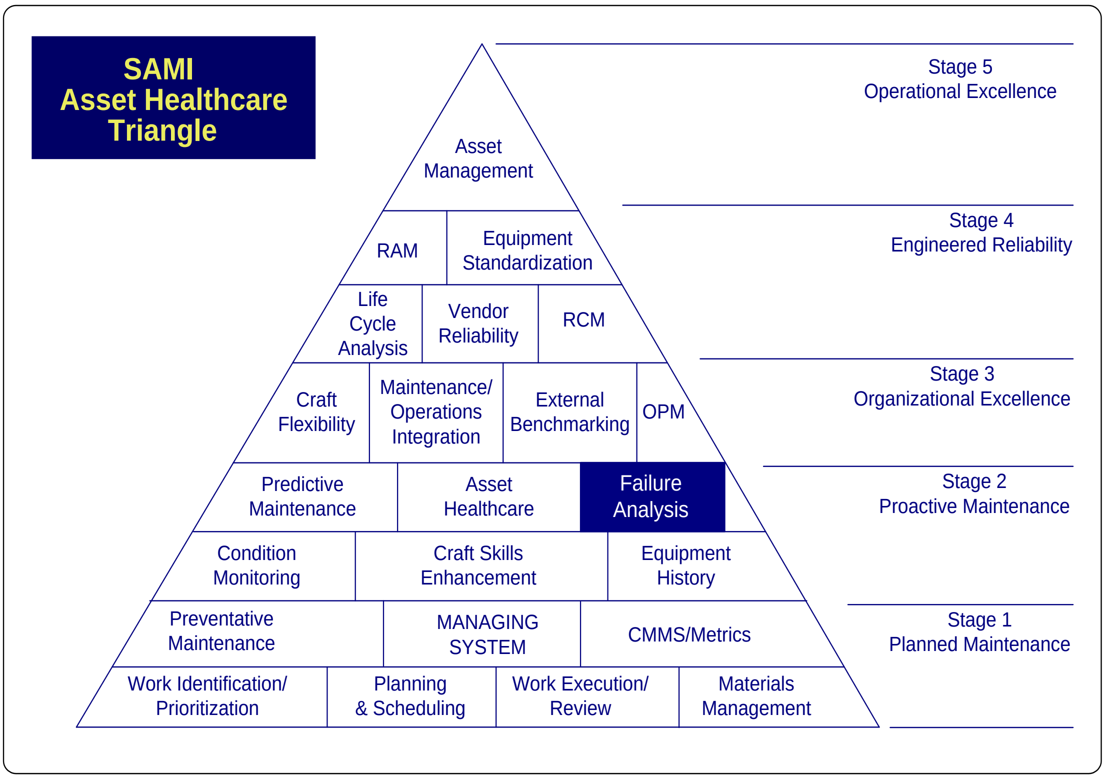


Figure 17: Failure Analysis

The focus of failure analysis in this thesis is on the various symptoms and fault model that has been developed and used in the configuration for all the different assets implemented in the proposed integrated asset management solution. The different symptoms and faults for the non-intelligent equipment (Joubert 2005) will be discussed.

4.1 Building plant assets in Asset Manager

An important aspect of the Action Research Process discussed in Chapter 3 includes the creation of an asset maintenance blueprint to form a benchmark (or point of departure for creating the different plant assets in the Asset Manager R300 (see 2.6.2).

The asset maintenance blueprint contains all the required information regarding plant assets so that the Asset Manager can be correctly configured. It is intended that a total of 4140 assets can be created and configured, based on the information contained in the blueprint.

Figure 18 shows the steps that are followed to build the plant assets within the Asset Manager interface, the symptoms and fault models and all the DCS hardware. The first step is building the assets using the Asset Builder application (see 2.6.2.5). Once all the assets have been created (or built) the symptoms and fault model is used to configure the symptoms and faults for every configured asset. Symptoms and faults are configured using the Diagnostic Builder (see 2.6.2.6) application.

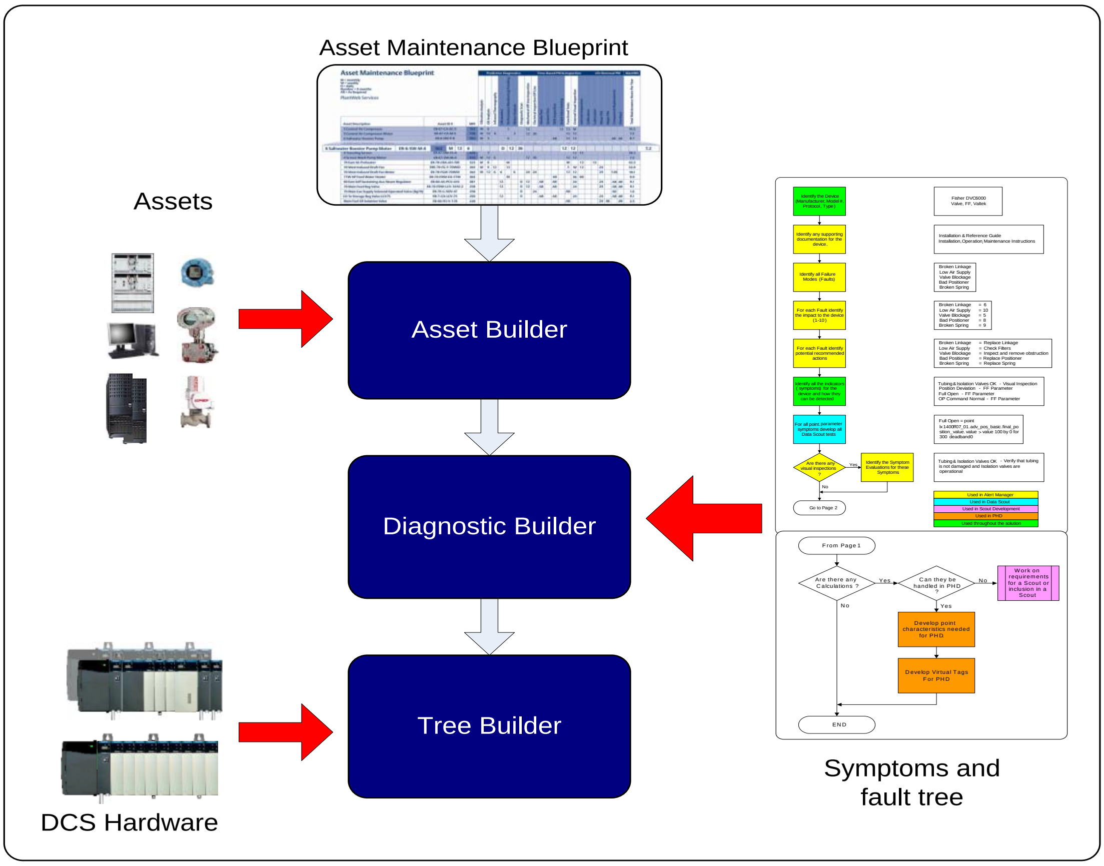


Figure 18: Steps to build assets

All DCS (Distributed Control System) assets are built using the TreeBuilder (see 2.6.2.7) and written into the Asset Managers infrastructure. PlantScape Hardware assets also include the PlantScape Servers (PSc_Server) and PlantScape Operator Stations (PSc_Station) as well as the Network Infrastructure (Network Asset).

The computer hardware is monitored via Plant Historian Database (PHD) that receives the data from a Performance Monitor real time data interface (RDI). This means that any information that is available from the Microsoft Windows Performance Monitor can be logged in PHD. In addition this information will be used to establish symptoms such as low available disk space, thread counts, CPU processes and available memory.

The symptom and fault model that is used to configure the required information for each of the plant assets in Alert Manager is discussed below in terms of the Fault Model Flow diagram.

4.2 Fault Model Flow Diagram

The fault model flow diagram (Figure 19a and 19b) was developed to determine the specific symptoms and faults associated with the various HART-enabled field devices and plant control systems. The example of a Fisher DVC 6000 valve is used to describe the fault model. This model is also used to formulate the processes for RCFA and FMEA (see 1.2.2) used for failure analysis.

The colour scheme at the bottom right of figure 19a refers to the different systems that are used to configure the symptoms and faults. Configuration information of the symptoms and fault tree will be displayed in the AlertManager. The DataScout is configured with the required parameters in order to determine the impact of the identified symptoms on HART-enabled field devices as well as non-HART assets. In addition the DataScout can be configured to determine any combination of these symptoms that may generate a fault condition.

Figure 19a, shows how symptoms are identified and how these symptoms are linked to a particular device. The parameters for the valve that will be used as symptoms for possible failure or malfunctions are indicated on the right hand side of figure 19a, shown below.

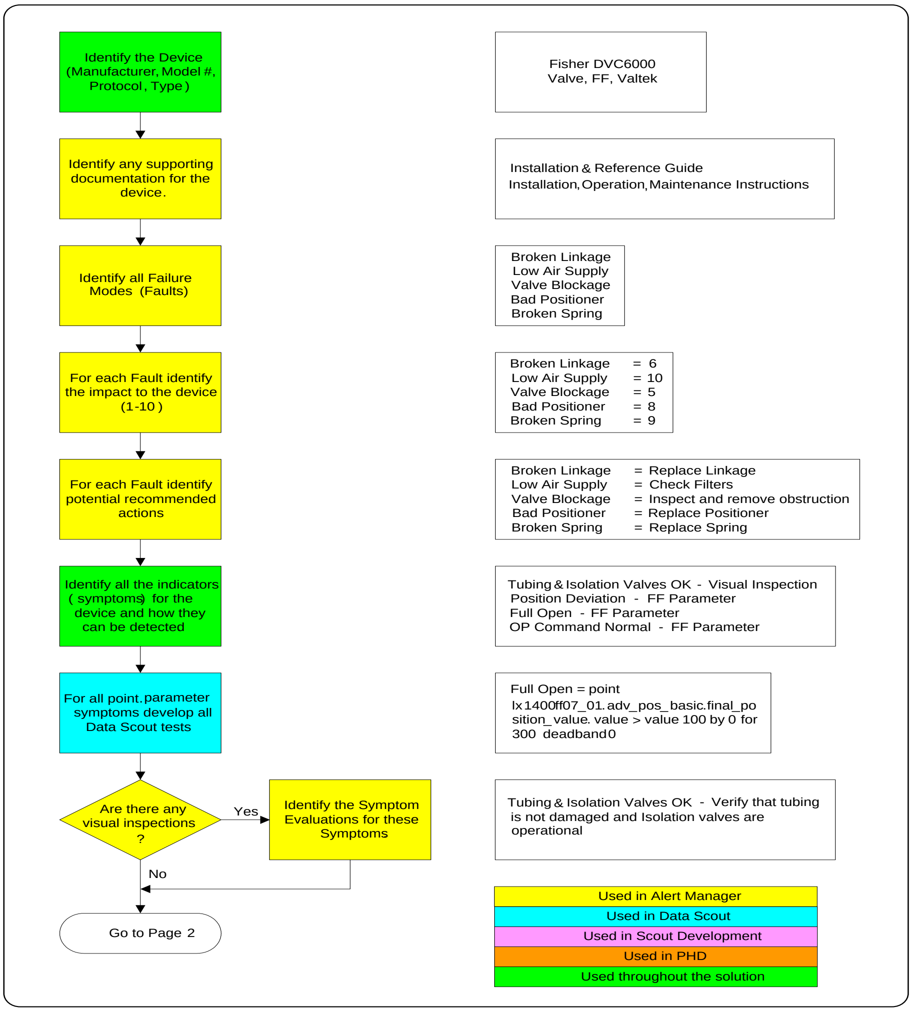


Figure 19a: Typical fault model for a Fisher DVC 6000 valve – part 1

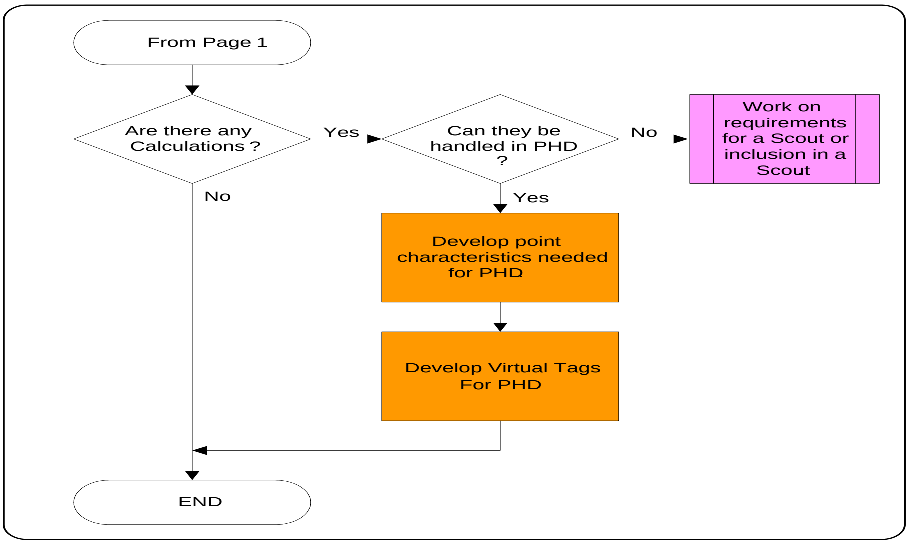


Figure 19b: Typical fault model for a Fisher DVC 6000 valve - part 2

The yellow blocks in Figure 19a are configured in the AlertManager and the brown tags shown in Figure 19b are configured in PHD (Plant Historian Database).

The light blue block (figure 19a) is used in the configuration of the DataScout where the parameters are configured for the different symptoms criteria. Figure 19b shows the various parameters required to configure and enable the DataScout in order to activate symptoms and faults in the AlertManager.

Symptoms are separately developed for non intelligent equipment such as the FSC system or retrieved from the device descriptor (DD) files from intelligent equipment such as HART-enabled devices as described in 2.2.1.

4.3 Symptom Configuration for a System Tag

According to the blueprint layout that was discussed in the preceding chapter, the symptoms for particular non-intelligent system assets are predefined as indicated in the symptoms tables. The DataScout interface shown in Figure 20 is used to build and configure the process symptoms for a particular asset.

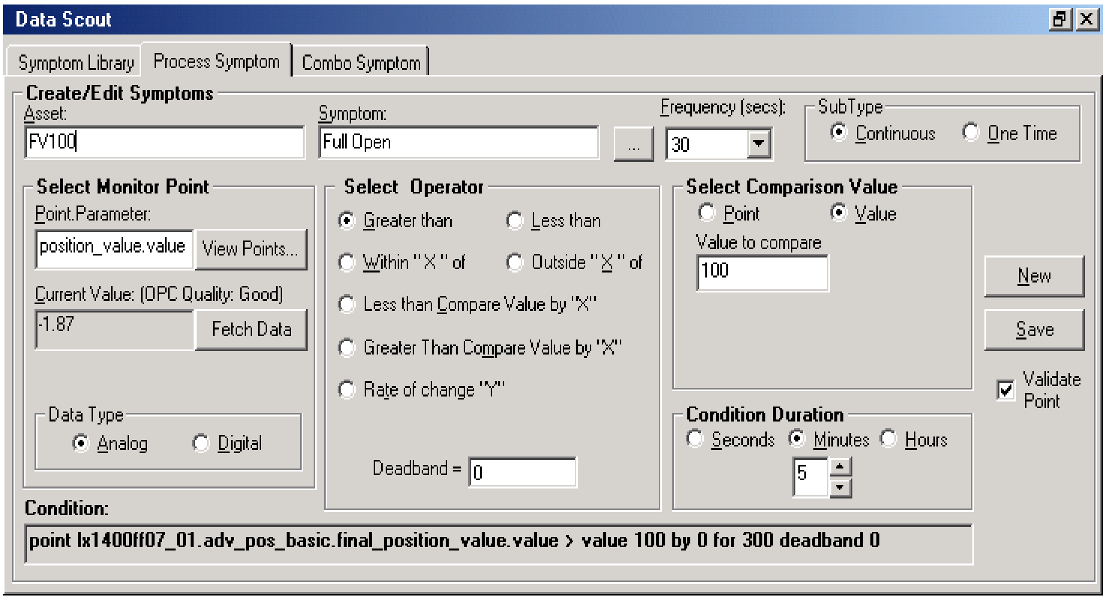


Figure 20: DataScout Process Symptom configuration

The asset that was created in Asset Builder is shown in the asset block. The point.parameter block indicates the virtual tag built into the real-time performance RDI on PHD. It is possible to verify the data through the OPC interface to PHD. When a value is returned it means that the OPC interface (see 2.8) has retrieved the correct data from the historian database. In the data type block a selection is made between analog or digital input. If analog is selected it refers to equipment that has an ON, OFF condition. The digital data type is used when interfacing to the different DCS and FSC systems.

Different operators are used to configure the symptom conditions in addition to condition duration in order to establish the length of time that the symptom condition must be active for a fault condition to be activated.

The sample frequency is specified to determine the sampling of the point parameters and when needed the point condition is compared to a value. This determined by the type of system and symptom. The condition information can be viewed at the bottom of Figure 20. The point is compared to a certain value for certain duration within a certain dead band; should these parameters be exceeded then an alert will be generated by the DataScout into the AlertManager infrastructure (Honeywell 2006a).

The dead band is used to desensitise the triggering of alerts within a certain range around the mean. The symptom parameters for all devices and systems were verified and included in the blueprint design in order to ensure that a valid alert is generated when these device symptoms are activated in the field devices. This process is followed for all assets that are used on the three Sasol Solvents Plants.

4.4 Process Historian Database (PHD)

The majority of the data that is required to make decisions regarding whether a symptom is present or absent resides in PHD. The PHD forms the benchmark according to which all DataScout evaluations will be made. Figure 21 indicates the various RDI's running on PHD and collecting data from the different interfaced systems.

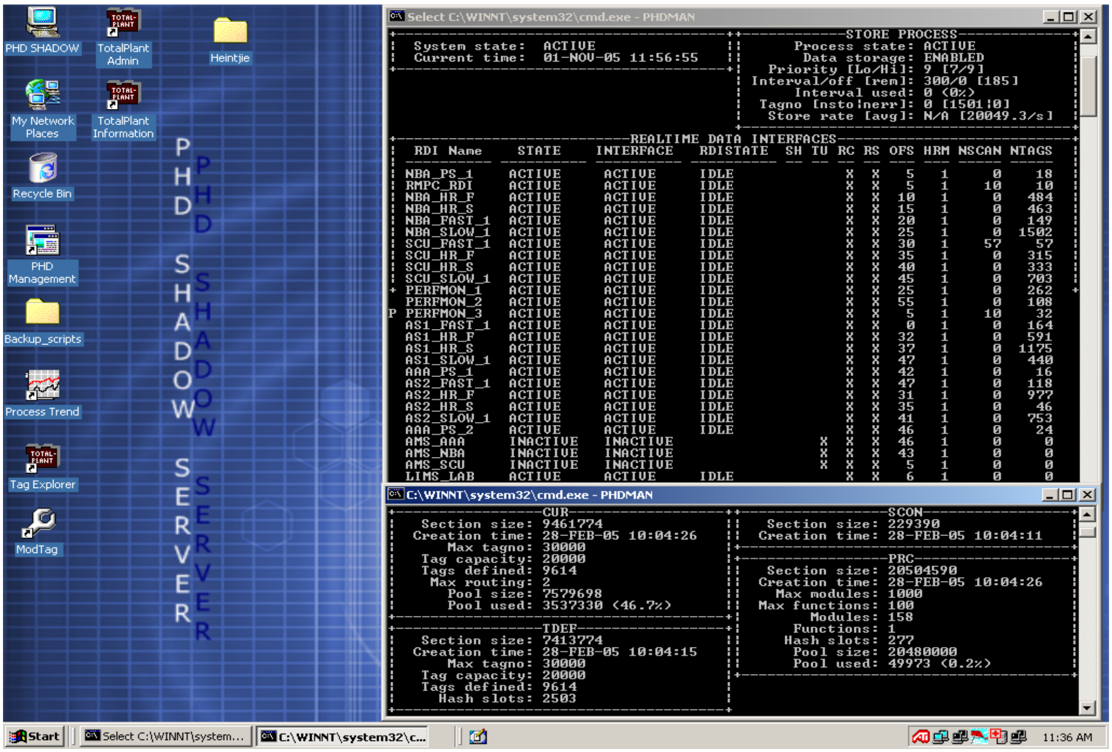


Figure 21: Real-time data interface on the PHD shadow server

4.5 DataScout

DataScout is a tool that connects to any OPC data source to retrieve data. DataScout uses a set of preconfigured rules to determine whether a symptom is present and then reports the result to AlertManager. DataScout connects without difficulty to the PHD OPC Server for data retrieval. The AlertManager client software installed on the PHD server will connect to the AlertManager server via the client software (Honeywell 2006a) to retrieve the required data.

For systems that do not have onboard diagnostic information, the DataScout is used to generate and configure the symptoms and faults. An asset is generated and the different symptoms and faults are manually created for the asset.

Point parameters are created as a virtual tag in PHD. This data is accessible from the DataScout through the different OPC connections (OPC Foundation 1997) to the different DCS, ESD or other plant control equipment, OPC servers and client connections.

4.6 DataScout Activation of Plant Control Systems Assets

The highlighted blocks in Figure 22 indicate the systems that are affected by the DataScout interface. The DataScout is used to activate the symptoms and fault models for the systems that are shown as not having onboard diagnostic information. HART and Foundation Fieldbus (FF) enabled field devices (see 2.2.1) do have onboard diagnostic information available.

The systems referred to in Figure 22 are the PlantScape DCS (see 2.4.1) that will be managed by the ExperionScout (see 2.6.2.2) interface, populating the AlertManager should the hardware devices on the control-net network fail. The fail safe control (FSC) system (see 2.3.2.), the PlantScape DCS servers and PlantScape stations are interfaced to PHD (see 2.4.2) via the custom written performance monitoring real time data interfaces (RDI).

Non-PlantScape servers and stations form part of the control network that is activated using the DataScout interface. Loop management consists of the control loops on the DCS that are configured and interface to the AlertManager by means of the LoopScout software and interfaces (see 2.5.3).

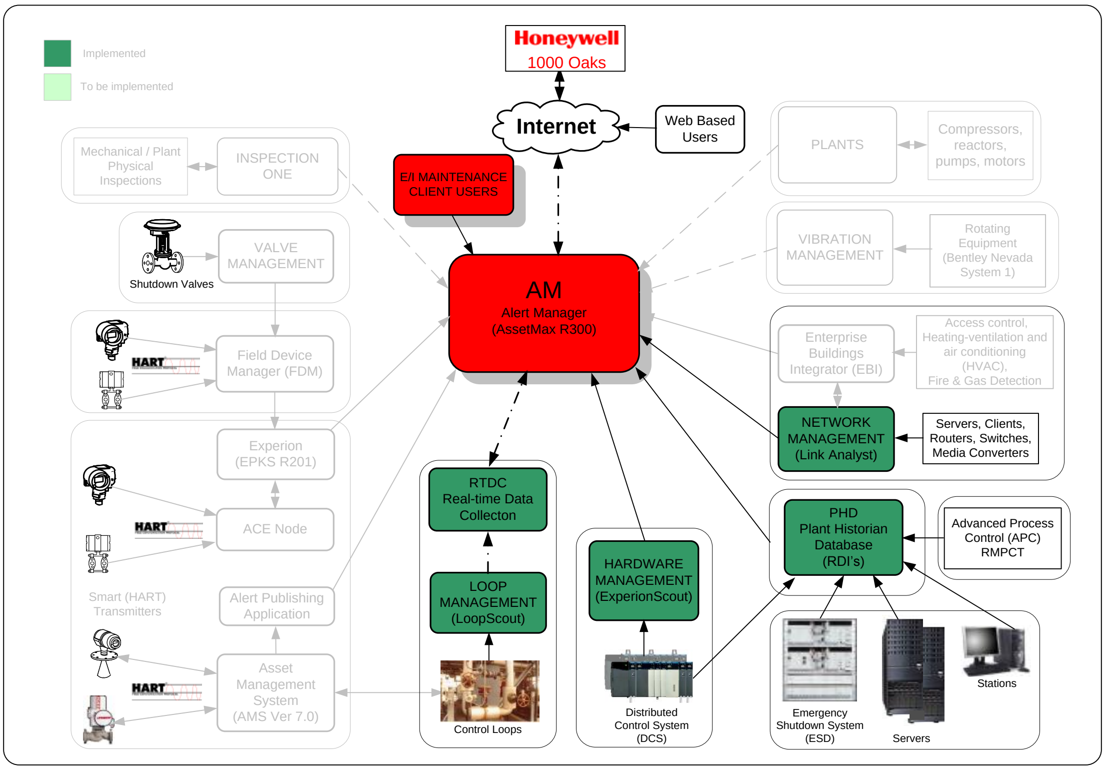


Figure 22: Block diagram indicating systems affected by the DataScout

4.7 Fault Tree Configuration for HART Based Device Tags

4.7.1 Device Descriptor (DD) Files

Use of the standard HART commands in HART-enabled field devices allows for greater functionality. These commands typically address on-line and diagnostic monitoring information. The HART, FF and PROFIBUS equipment are supplied with Device Descriptor (DD) files from the manufacturer that assist the user to identify device-specific features. These device specific features are typically used to access configuration properties and device-specific features (Pratt 2002:24).

According to Borst Automation (2006) the Device Descriptor Language (DDL) is a technology that has particular benefits for configuration and setup of device-specific features. DD files are optional for the HART protocol. All HART-enabled devices have a corresponding DD file registered with the HART Communication Foundation (HCF) (Helson 2005) that are used with the different field devices.

For a device such as the Fisher DVC6000 valve, the DD files are imported into the AlertManager where the configured device-specific symptoms are displayed and can be linked to the fault tree. The faults must be generated from the AlertManager application and then linked to the specific faults that are associated with specific filed devices. Figure 23 shows a "failure" fault being linked to the device specific symptoms that must be active before the fault will produce an alert. For the failure fault tree, ten symptoms were linked to produce the failure alert.

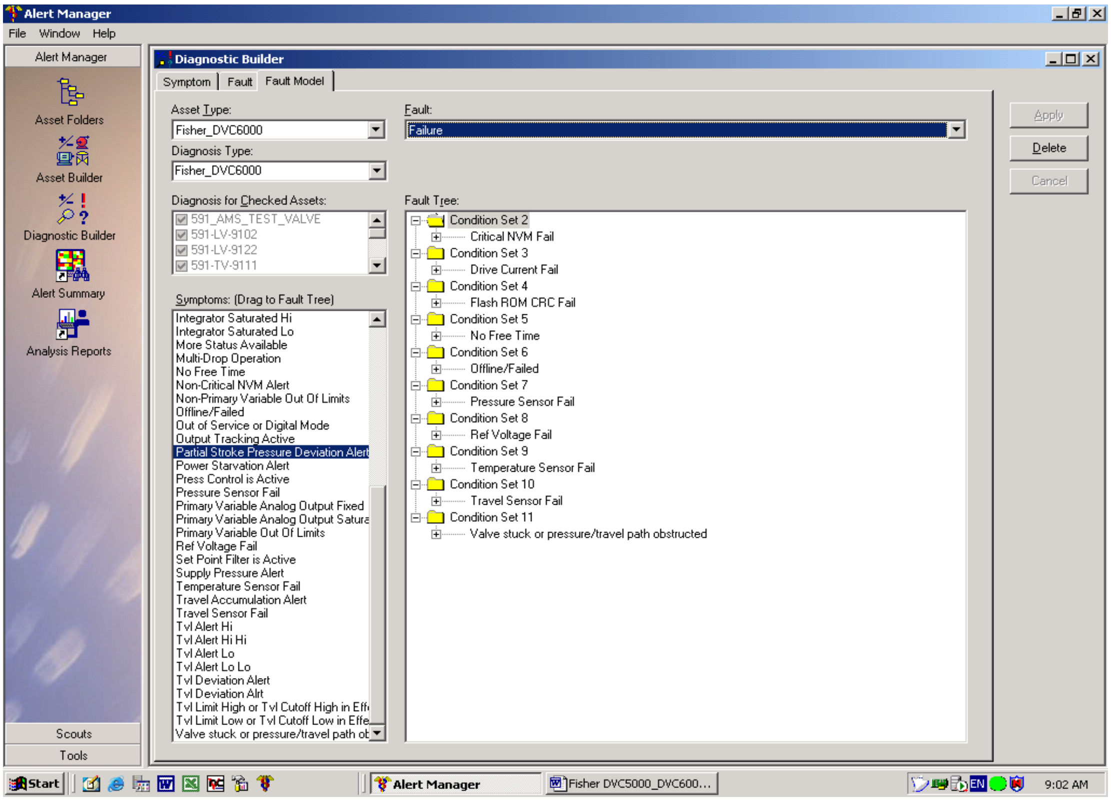


Figure 23: Diagnostic configuration to link symptoms to the fault tree model

The linking of symptoms is performed for all device related faults in order to ensure that the correct alerts are generated. Figure 24, overleaf, displays the configured symptoms from the imported DD files in the AlertManager for the specific

Fisher_DVC6000 valve. No active symptom is shown that can activate a fault condition for this specific valve. In addition Figure 24 shows that there are other multiple asset alerts active (shown in red – Fisher_DVC6000 Multiple Asset Alerts). This is from other valves that are part of the asset type group Fisher_DVC6000, (Joubert 2006:37).

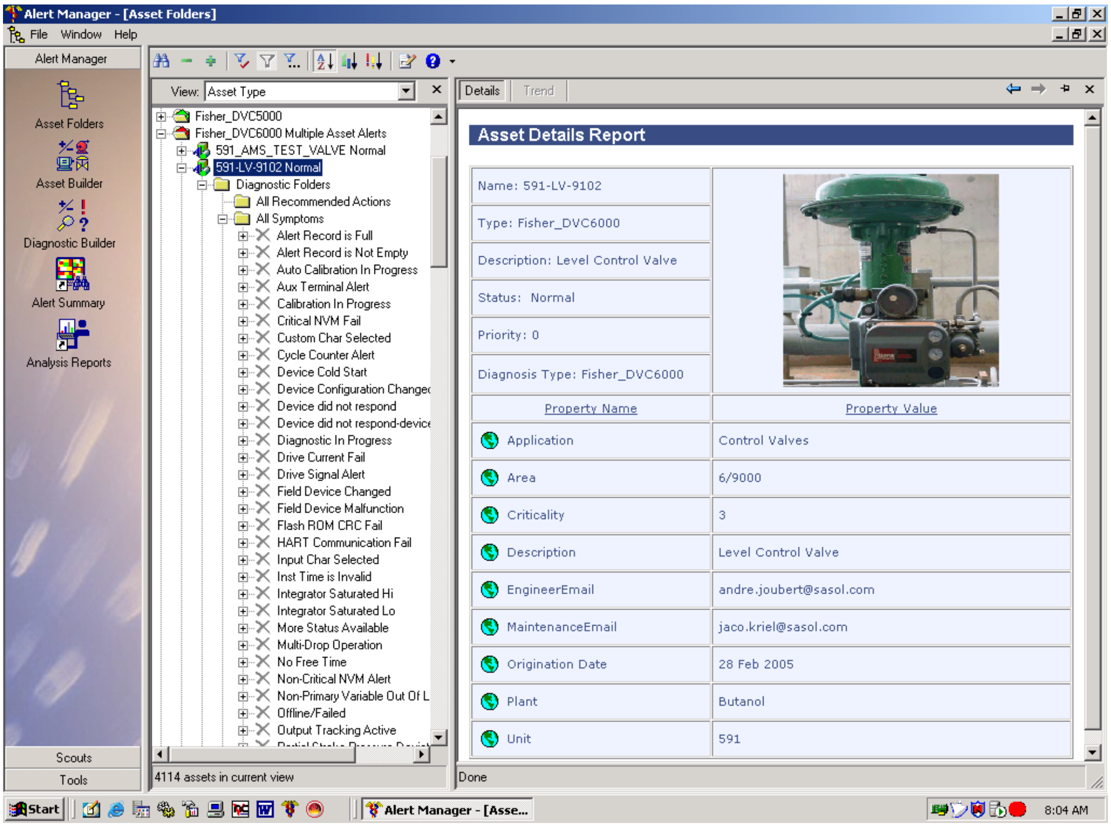


Figure 24: Fisher DVC6000 symptoms display in AlertManager

4.8 PlantScape Hardware

The PlantScape hardware that is configured includes the following:

- PSc_C200 Cntrl Processor module
- PSc_Chassis_Series-A_IO Module
- PSc_CNET Interface Module
- PSc_FF Interface Module
- PSc_FF Link

- PSc_Redundancy Module
- PSc_Serial_Interface Module
- PSc_Server
- PSc_Station
- Network Asset

4.8.1 PlantScape Symptoms

The symptoms for the DCS Hardware are created from events as reported in the PlantScape event log. These symptoms are created in AlertManager by the ExperionScout (see 2.6.2.2) as they become active on the DCS. The system administrator is required to apply the notification philosophy to these symptoms on the first occurrence. Subsequent symptoms will automatically generate the expected notifications.

In addition to the automatically created symptoms, several symptoms are available for the computer hardware associated with the PlantScape Servers and PlantScape Operator Stations. These symptoms are listed in Table 2.

4.8.2 PlantScape Faults

PlantScape symptoms related to DCS problems will have to be included into faults on an ongoing basis as these symptoms will only become available in AlertManager once they have become active in the event log. In addition to these faults the symptoms pertaining to the physical health of the server can be included in fault models as shown in Table 1. These specific faults were obtained from Microsoft operating system parameters used for hardware monitoring.

Table 1: PSc_Server and PSc_Station faults

Fault	Condition Set	Symptom
Resource problem	1	C-Drive % Free Space LOW
	2	D-Drive % Free Space LOW
	3	E-Drive % Free Space LOW
	4	Memory Available LOW
	5	Processor 1 Busy
	6	Processor 2 Busy
Computer Problem	1	Network Activity Absent
	2	Machine down
	3	Route traffic down

Table 2: PSc_Server and PSc_Station symptoms

Symptom	Driver	Description
C-Drive % Free Space LOW	DataScout to PHD	% Free Space < 15%
D-Drive % Free Space LOW	DataScout to PHD	% Free Space < 15%
E-Drive % Free Space LOW	DataScout to PHD	% Free Space < 15%
Memory Available LOW	DataScout to PHD	Memory Available < 128Mb for 6 hours
Processor 1 Busy	DataScout to PHD	Processor free time < 10% for 6 hours
Processor 2 Busy	DataScout to PHD	Processor free time < 10% for 6 hours
Network Activity Absent	DataScout to PHD	Network activity < x Bytes/sec for 6 hours
Machine down	LinkAnalyst	LinkAnalyst is unable to connect to specified machine.
Route traffic down	LinkAnalyst	LinkAnalyst is unable to connect to specified machine.

4.9 Experion Scout

Experion Scout connects to the PlantScape DCS Alarm and Events OPC Server and subscribes to certain events. The events associated with the DCS hardware are then reported to the AlertManager as symptoms.

4.10 FSC hardware

A set of performance and maintenance related points will be created on the DCS for each FSC that is connected by means of Ethernet network cables. These points will be stored in the PlantScape DCS database for use in displays, groups, trending, etc. This information will be collected and imported to the PHD tags and use DataScout to interrogate this information for Symptom/Fault generation.

4.10.1 Integration

It is necessary to create Supervisory Control and Data Acquisition (SCADA) points in QuickBuilder (located on the DCS server) for each FSC parameter used. Each of these SCADA points is then collected via the performance monitoring RDI on the PHD server. Table 3 provides a summary of the created parameters that will be collected and monitored.

Referring to table 3 and 5, the parameters are presented where:

- **Controller:** is the number of the controller connecting to the specific FSC as configured in PlantScape
- **XXX:** is an abbreviation for the plants 591, 592, 593 or 597
- **Y:** number of the FSC for the specific plant
- **Z:** which central part, A and B

Table 3: FSC Parameter Integration

Description	File	Record	Word (A)	Word (B)	Format	PHD Tag (example)
Number of external diagnostic messages	132	Controller Offset	555	556	Integer 2	591_FSC_1A_DM
Information Connection Status	132	Controller Offset	17	18	Integer 2	XXX_FSC_YZ_CS
Current Temperature	132	Controller Offset	577	578	Integer 2	XXX_FSC_YZ_CT
Temperature Alarm	132	Controller Offset	581	582	Integer 2	XXX_FSC_YZ_TA
Maximum Application Cycle Time	132	Controller Offset	541	542	Integer 2	XXX_FSC_YZ_ACT
Process Safety Time	132	Controller Offset	561	562	Integer 2	XXX_FSC_YZ_PST
Number of Forces	132	Controller Offset	553	554	Integer 2	XXX_FSC_YZ_NF
Force Status	132	Controller Offset	551	552	Integer 2	XXX_FSC_YZ_FS
Central Part Status	132	Controller Offset	549	550	Integer 2	597_FSC_1A_ CPS

4.10.2 Faults

The set of faults for this asset type that is configured is shown in Table 4. The condition set is the SCADA point reference built in QuickBuilder (see 2.4.1)

Table 4: FSC hardware faults

<table>
<tr><th>Fault</th><th>Condition Set</th><th>Symptom</th></tr>
<tr><td rowspan="6">FSC Force Fault</td><td>1</td><td>Forces Present (A)</td></tr>
<tr><td>2</td><td>Forces Present (B)</td></tr>
<tr><td rowspan="2">3</td><td>Force Override ENABLED (A)</td></tr>
<tr><td>NOT Forces Present (A)</td></tr>
<tr><td rowspan="2">4</td><td>Force Override ENABLED (B)</td></tr>
<tr><td>NOT Forces Present (B)</td></tr>
<tr><td rowspan="10">General FSC Fault</td><td>1</td><td>Central Part Status Not RUN (A)</td></tr>
<tr><td>2</td><td>Cycle Time Close To Process Safety (A)</td></tr>
<tr><td>3</td><td>External Diagnostic Messages Present (A)</td></tr>
<tr><td>4</td><td>Information Connection Status Not HEALTHY (A)</td></tr>
<tr><td>5</td><td>Temperature Alarm (A)</td></tr>
<tr><td>6</td><td>Central Part Status Not RUN (B)</td></tr>
<tr><td>7</td><td>Cycle Time Close To Process Safety (B)</td></tr>
<tr><td>8</td><td>External Diagnostic Messages Present (B)</td></tr>
<tr><td>9</td><td>Information Connection Status Not HEALTHY (B)</td></tr>
<tr><td>10</td><td>Temperature Alarm (B)</td></tr>
</table>

4.10.3 Symptoms

The set of symptoms for this asset type that is configured is shown in Table 5. The driver shows what interface is used.

Table 5: FSC hardware symptoms

Symptom	Driver	Description
Information Connection Status Not HEALTHY (A)	DataScout to PHD	591_FSC_1A_CS <> 1
External Diagnostic Messages Present (A)	DataScout to PHD	XXX_FSC_YZ_DM > 0
Temperature Alarm (A)	DataScout to PHD	XXX_FSC_YZ_TA < 1
Forces Present (A)	DataScout to PHD	XXX_FSC_YZ_NF > 0
Force Override ENABLED (A)	DataScout to PHD	XXX_FSC_YZ_FS > 0
Central Part Status Not RUN (A)	DataScout to PHD	3 > XXX_FSC_YZ_CPS > 2
Cycle Time Close To Process Safety (A)	DataScout to PHD	(XXX_FSC_YZ_PST - XXX_FSC_YZ_ACT) < 100mSec
Information Connection Status Not HEALTHY (B)	DataScout to PHD	XXX_FSC_YZ_CS <> 1
External Diagnostic Messages Present (B)	DataScout to PHD	XXX_FSC_YZ_DM > 0
Temperature Alarm (B)	DataScout to PHD	XXX_FSC_YZ_TA < 1
Forces Present (B)	DataScout to PHD	XXX_FSC_YZ_NF > 0
Force Override ENABLED (B)	DataScout to PHD	XXX_FSC_YZ_FS > 0
Central Part Status Not RUN (B)	DataScout to PHD	3 > XXX_FSC_YZ_CPS > 2
Cycle Time Close To Process Safety (B)	DataScout to PHD	(XXX_FSC_YZ_PST - XXX_FSC_YZ_ACT) < 100mSec

4.11 Network Assets

Network assets include non-PlantScape servers such as the RTDC, SSBACAM, PHD buffers and NW_Mon. Non-PlantScape work stations such as AMS, FieldCare and the network infrastructure necessary to ensure reliable operation of the DCS and supporting functions are included in the solution. Specific RDI’s are developed and implemented on the PHD shadow server to collect data from the Microsoft Windows Performance Monitor interface used to collect several performance metrics from servers and work stations into PHD. These performance metrics are also monitored via DataScout.

LinkAnalyst (see 2.5.2) is used to monitor the health of several critical machines and switches on the process control domain. It has the capability to execute a program when an error is reported (present or returned to normal) for a specific asset. One of the methods of triggering symptoms in AlertManager is via a program called mksymptm.exe that is used in conjunction with command line arguments to generate symptoms in the AlertManager. Mksymptm.exe will be used to generate alerts for critical assets every time LinkAnalyst reports an alert. Refer to tables 6 and 7 for the symptoms and faults. For all the network assets these command line arguments are developed and interfaced to the different assets.

Table 6: Network Asset symptoms

Symptom	Driver	Description
Route traffic down	LinkAnalyst	LinkAnalyst is unable to connect to specified machine.

Table 7: Network Asset faults

Fault	Condition Set	Symptom
Network Problem	1	Route traffic down

4.12 Control loops

Control loops are monitored for maximum performance to ensure that the plant operates at maximum design capability. The LoopScout service (see 2.5.3) enables the user to collect data from the DCS and then upload the captured data by means of various software shuttles to a server at Honeywell in 1000 Oaks, USA. The data is analysed and a report is generated to indicate the condition of the sampled control loops.

4.12.1 Integration

The LoopScout software was installed on the Real Time Data Collector (RTDC) server and the data collectors were initialized to begin data collection from the different DCS systems as used in the Sasol Solvents environment (Figure 25). The results were downloaded every week and a web interface was designed to populate the AlertManager automatically. The AlertManager is able to identify and indicate poorly tuned loops and unacceptable performance parameters (Honeywell 2005).

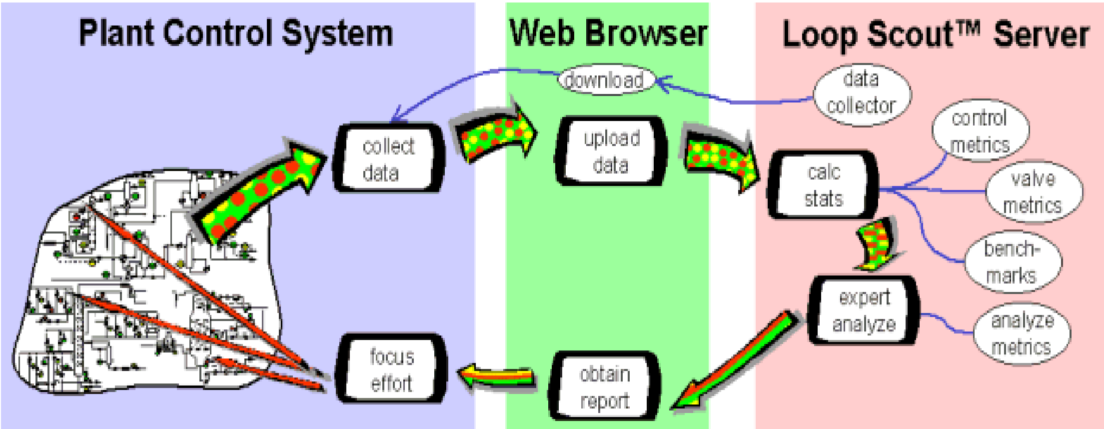


Figure 25: Block diagram of the LoopScout collection and reporting process

4.12.2 Symptoms

Table 8 shows the set of symptoms configured for this asset type. The driver is the LoopScout interface.

Table 8: Control loop symptoms

Symptom	Driver	Description
Inactive	LoopScout	Loop is inactive (values do not change)
Saturated	LoopScout	Control Loop is saturated (OP is at 0% or 100%).
Open Loop	LoopScout	Control Loop is in MAN.
Poor Performance	LoopScout	Loop performance is poor.
Fair Performance	LoopScout	Loop performance is fair.
Acceptable Performance	LoopScout	Loop performance is acceptable.

4.12.3 Faults

Table 9 shows the Conditions Sets that are configured as faults that for this asset type. Poor or fair performance is defined from the actual diagnostic info obtained from the loop information.

Table 9: Control loop faults

Fault	Condition Set	Symptom
Unacceptable Performance	1	Inactive
	2	Saturated
	3	Open Loop
	4	Poor Performance
	5	Fair Performance

4.13 DataScout configuration for FSC assets

By referring to the different symptoms specified in the tables above, the configured data can be observed from the DataScout for the FSC asset in Figure 26. The particulars of the specific symptom configuration are indicated in the DataScout configuration as shown in Figure 24. The configured symptoms and the fault tree for the FSC asset in the AlertManager display are shown in Figure 26.

The AlertManager makes it possible to view the symptoms and faults in one single view. Maintenance staff can see the status of the different types of configured assets configured for the various plants, plant areas and types of equipment.

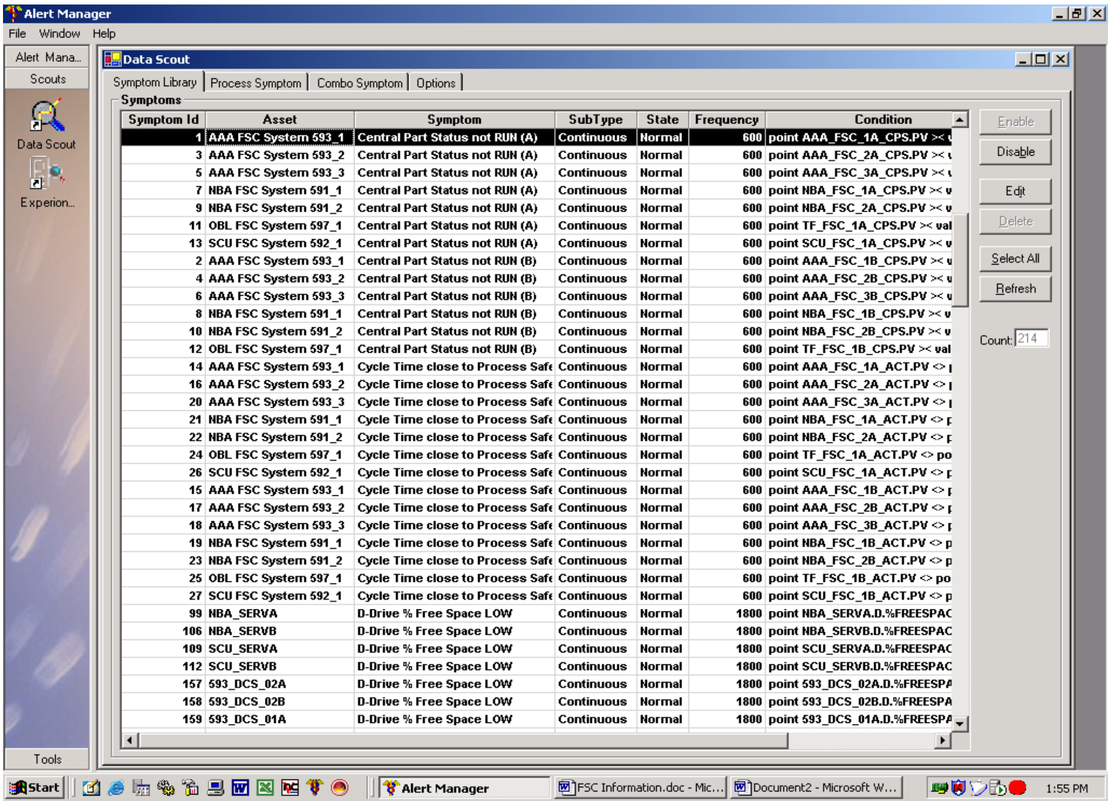


Figure 26: Configured symptoms for FSC assets

It is possible to obtain the history of failures per symptom and fault for every configured asset. This is discussed Chapter 6 which considers equipment history and how historic information is used in Root Cause Failure Analysis (RCFA) and maintenance processes.

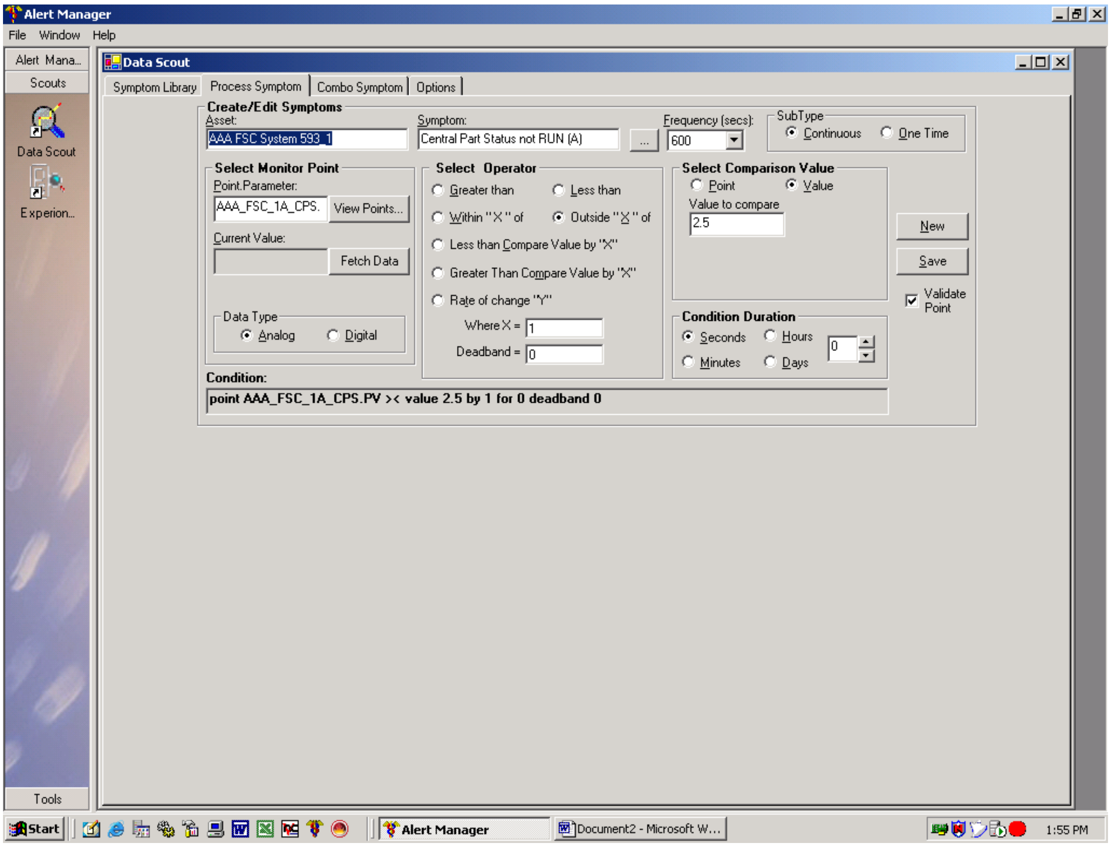


Figure 27: FSC process symptom configuration

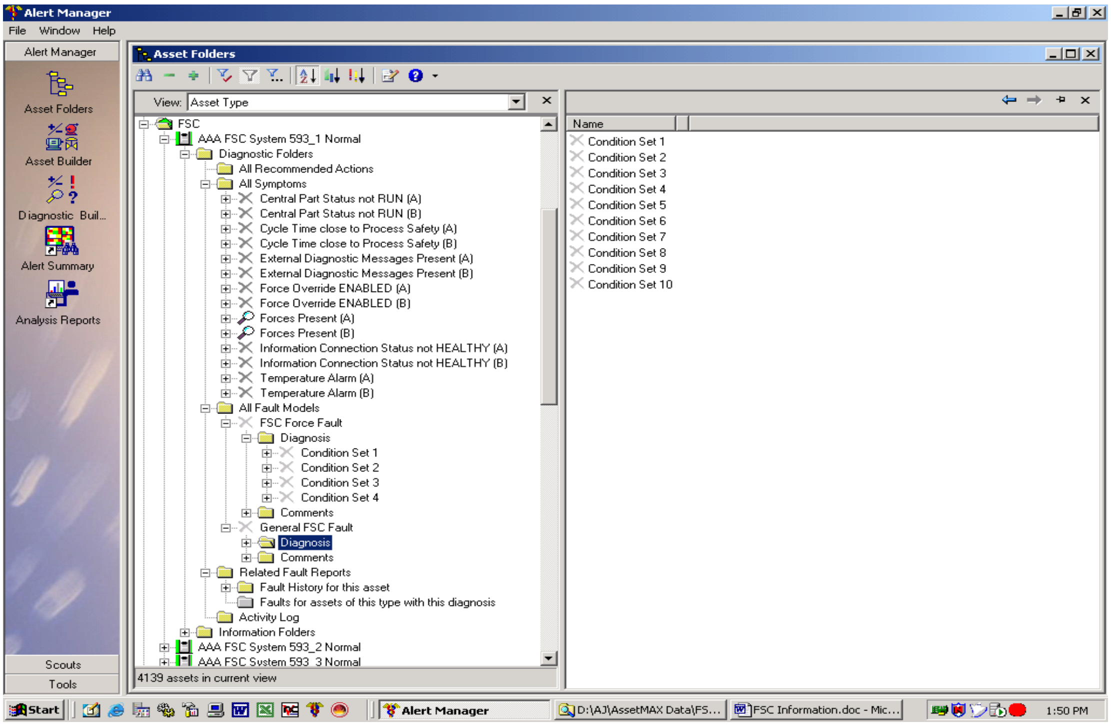


Figure 28: FSC asset view of symptoms and fault tree

4.14 Failure analysis from AlertManager

Failure analysis is an investigation of data obtained from the symptoms and faults of equipment failure in order to the causes of these failures. This information is obtained from the AlertManager and is used in root cause failure analysis (RCFA) and failure modes and effects analysis (FMEA).

Information from AlertManager is configured to address a particular need in the RCFA or FMEA. Reports are generated and in the Sasol Solvents environment, all the reports and views from AlertManager have a custom configuration.

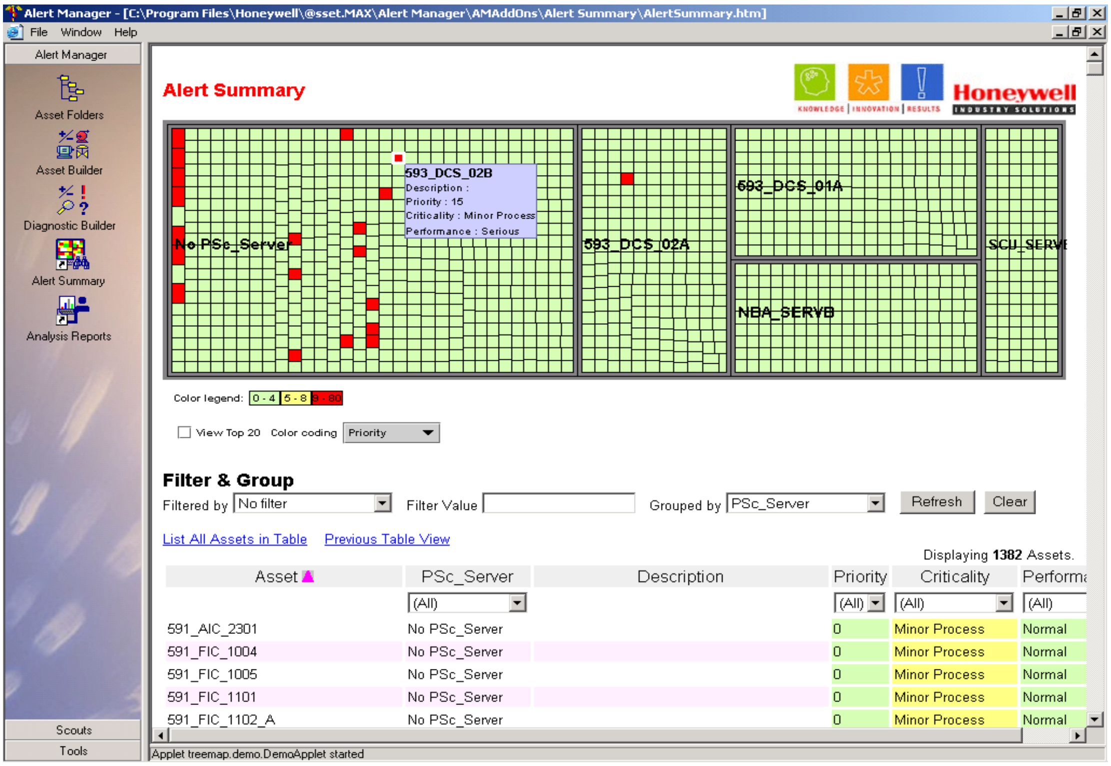
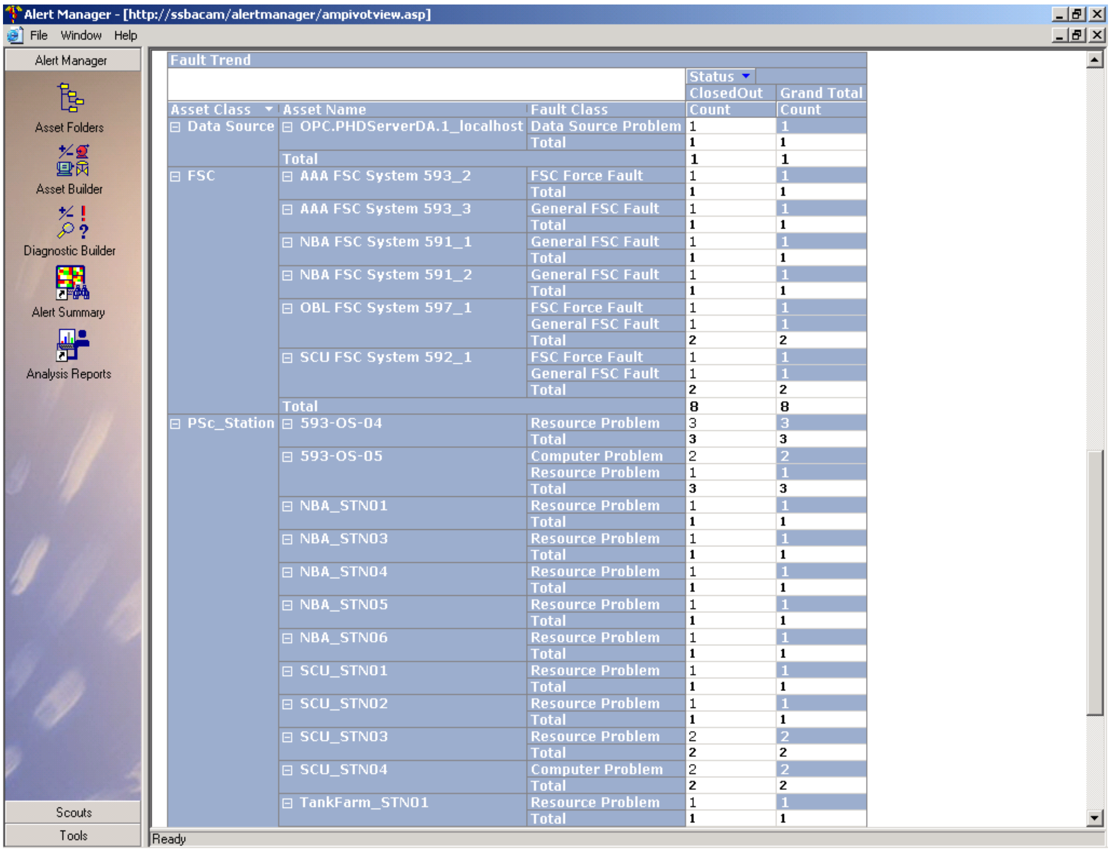


Figure 29: Alert summary of PlantScape assets

The reports were configured according to plant requirements specified in the blue print including specific equipment in particular plant areas, faults per area, faults per type of equipment and faults in a specific time period. Figure 29 indicates an alert summary of the different PlantScape hardware equipment. The server names are displayed and the red blocks indicate certain alerts. If the red block is activated as shown in figure 29, it will show the device in a fault condition. This particular summary will view what the status is of the system being monitored.

Another type of view is shown in figure 30. A specific asset is shown where the faults is generated and corrected. They would either be corrected by the system itself or by intervention of maintenance personnel. The report shows individual faults and a total of faults produced by an asset. This report is generated over a period of a month and this data is used in a RCFA process to determine why the station's resources were running low at certain periods of operation.

By using this type of failure analysis information, it is possible to adapt the maintenance strategies and maintenance procedures.



			Status	
			ClosedOut	Grand Total
Asset Class	Asset Name	Fault Class	Count	Count
⊟ Data Source	⊟ OPC.PHDServerDA.1_localhost	Data Source Problem	1	1
		Total	1	1
	Total		1	1
⊟ FSC	⊟ AAA FSC System 593_2	FSC Force Fault	1	1
		Total	1	1
	⊟ AAA FSC System 593_3	General FSC Fault	1	1
		Total	1	1
	⊟ NBA FSC System 591_1	General FSC Fault	1	1
		Total	1	1
	⊟ NBA FSC System 591_2	General FSC Fault	1	1
		Total	1	1
	⊟ OBL FSC System 597_1	FSC Force Fault	1	1
		General FSC Fault	1	1
		Total	2	2
	⊟ SCU FSC System 592_1	FSC Force Fault	1	1
		General FSC Fault	1	1
		Total	2	2
	Total		8	8
⊟ PSc_Station	⊟ 593-OS-04	Resource Problem	3	3
		Total	3	3
	⊟ 593-OS-05	Computer Problem	2	2
		Resource Problem	1	1
		Total	3	3
	⊟ NBA_STN01	Resource Problem	1	1
		Total	1	1
	⊟ NBA_STN03	Resource Problem	1	1
		Total	1	1
	⊟ NBA_STN04	Resource Problem	1	1
		Total	1	1
	⊟ NBA_STN05	Resource Problem	1	1
		Total	1	1
	⊟ NBA_STN06	Resource Problem	1	1
		Total	1	1
	⊟ SCU_STN01	Resource Problem	1	1
		Total	1	1
	⊟ SCU_STN02	Resource Problem	1	1
		Total	1	1
	⊟ SCU_STN03	Resource Problem	2	2
		Total	2	2
	⊟ SCU_STN04	Computer Problem	2	2
		Total	2	2
	⊟ TankFarm_STN01	Resource Problem	1	1
		Total	1	1

Figure 30: Fault trend report for specific assets

4.15 Root Cause Failure Analysis

Root cause failure analysis is the key to success in a good incident management process (Sasol 2005).

The business benefits of Root Cause Failure (Sasol 2005) are as follows:

- Reduces the re-occurrence of incidents and decreases production loss.
- Focuses on the problem and not on the people.
- Empowers people to solve plant related problems.
- Encourages team interaction between the different disciplines.
- Reduces time spent in circular discussion of the problem.

The personal benefits of Root Cause Failure Analysis (Sasol 2005) are presented below:

- No blame is put on an individual as the focus is on the problem.
- Offers the opportunity for maintenance personnel to give their inputs and make a difference in the maintenance process.
- Fosters creative thinking.
- Exposes employees to good plant maintenance practices..
- Interaction with team members from different disciplines with different levels of expertise.

Root cause failure analysis (RCFA) and failure modes and effects analysis (FMEA) are processes that address hypothetical as well as historical failure modes.

In Stage two, established failure modes are addressed and a modified FMEA approach must be followed to allow people to figure out bundles of related failures on equipment and dope out multiple causes (Blaney 2006). This will allow the production and maintenance personnel to investigate failures more effectively that could have an impact on the plants, people, equipment and the environment.

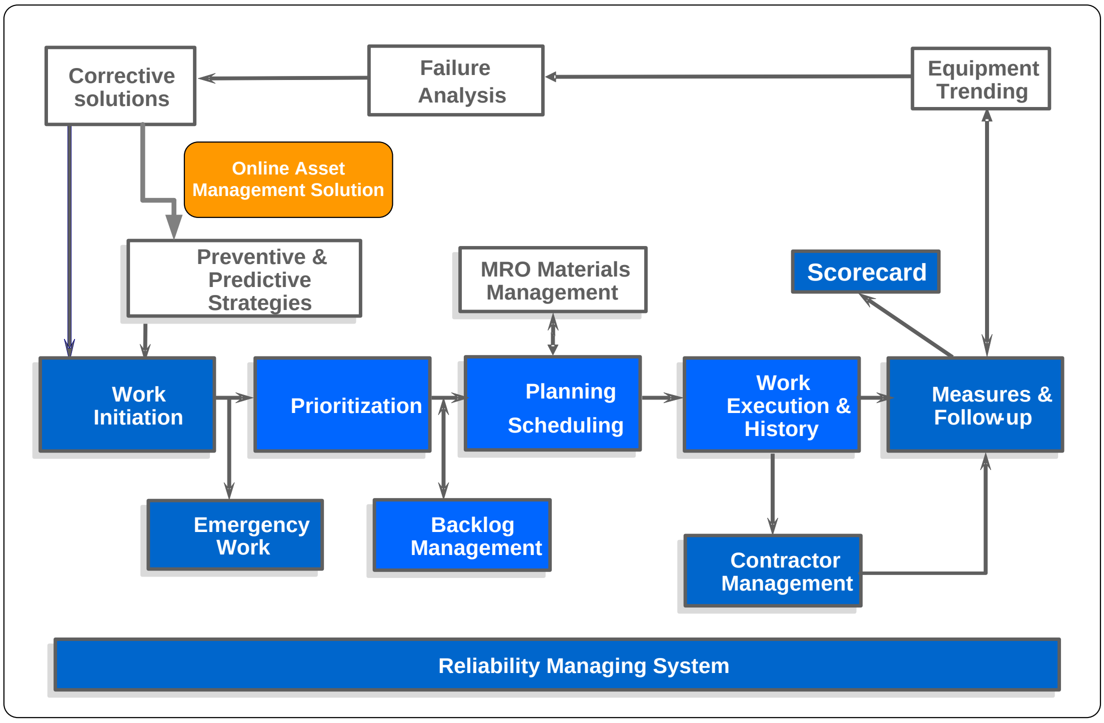


Figure 31: Basic work process for maintenance

Where does failure analysis fit into the bigger picture in the maintenance arena? In the Sasol Solvents environment it forms part of the basic work management process for maintenance as shown in figure 31. This process is followed to do maintenance and the RCFA (root cause failure analysis) and FMEA processes were developed to facilitate the investigation into equipment failure. The different views, reports and history from the AlertManager will be part of the complete process.

The outcomes from the failure analysis must be used to implement corrective actions and solutions as shown in figure 31. It is important to use the analysis data to be implemented in the specific maintenance strategies that will facilitate the work flow process to do the correct amount or type of maintenance (Joubert 2006:38-39).

4.16 Conclusion

This chapter has presented the symptom and fault models for the various types of assets used in the Sasol Solvents environment. The failure analysis processes were shown in the Sasol work process for maintenance. The different DataScout configurations were included to illustrate the setup and configurations that are configured for DCS, FSC and network systems. HART-enabled asset configuration was also discussed in terms of enabling the AlertManager to produce active alerts when equipment or systems are failing or have failed. In the next chapter the asset healthcare block from the SAMI model in stage 2 will be discussed.