

行政院及所屬各機關出國報告

(出國類別：其他)

「汰換桃園及松山機場低空風切警報 系統（LLWAS）採購案」 工廠測試 出國報告書

服務機關：民用航空局飛航服務總臺

姓名職稱：江世忠工務員

陳盈擘觀測員

派赴國家：德國杜塞爾多夫

出國期間：103.07.13 ~103.07.19

報告日期：103.09.02

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一、目的

本次廠測之主要目的在於測試「汰換桃園及松山機場低空風切警報(LLWAS)系統」採購案所採購之系統功能是否符合本總臺之合約規範，藉以確保本總臺所購系統之品質與性能。

根據統計資料，發生飛航事故最大機率為航機起飛及降落之時，尤以降落為最。航機降落時，距離地面已近，若有臨時發生之風切，導致風的方向或速度急遽改變，將反應不及導致不願發生之事件。低空風切警報(LLWAS)系統係利用架設於機場周遭之測風塔，收集機場周遭之風速及風向資料，據以分析風之幅散、幅合，根據美國大氣研究大學聯盟(UCAR)發展之第三代低空風切告警系統(Phase-III LLWAS)演算法，提供氣象及航管人員即時而正確的低空風切告警，藉以警告航機避免憾事發生。

上一代桃園及松山機場之低空風切警報系統於民國 90 年建置，至今使用已 13 年餘。臺灣地區本為高溫潮濕天氣，且桃園機場地近海濱；含鹽分海風吹拂之下，收集風速、風向資料之測風塔多有鏽蝕情況，為維護飛航安全以提供不間斷的低空風切告警服務，本採購案包含測風塔保養以及新系統建置一併進行。

依據本購案契約規定，廠商提供之系統需經完成工廠測試、功能測試及信心測試後始得報請正式驗收。與本案系統相關之伺服器及工作站電腦，將由臺灣廠商直接出貨，故本次 LLWAS 工廠測試為驗證系統軟體功能為主，以確認系統於安裝前符合需求；而相較於松山機場單跑道運作，桃園機場雙跑道運作狀況更為複雜，故本次驗證系統功能以桃園機場為驗證對象。伺服器及工作站電腦等硬體設備於陣地安裝前再行點驗，合先敘明。

二、廠測與會人員

總臺代表：

江世忠 飛航服務總臺/航電技術室/工務員

陳盈曄 飛航服務總臺/桃園航空氣象臺/觀測員

SELEX 公司代表：

Rene GraBelt/ Program Manager

神通資料(本案承商)代表：

張蒼民/ 專案經理

三、過程

本次廠測，本總臺選派 2 名人員前往系統製造商 SELEX 公司位於德國杜塞爾多夫之工廠舉行，測試期程共計 4 日(註：含行程共計 7 天)，相關行程如后：

- 1.103 年 7 月 13 日搭乘中華航空班機，由臺北飛往德國法蘭克福機場，於 7 月 14 日早上飛抵法蘭克福，之後改搭德國鐵路抵達杜塞爾多夫。
- 2.103 年 7 月 14 日下午起至 7 月 16 日：逐條進行工廠測試項目。
- 3.103 年 7 月 17 日：進行廠測資料整理，下午由雙方代表進行總結會議，並簽署本次廠測紀錄。
- 4.103 年 7 月 18 日：搭乘中華航空班機回程。
- 5.103 年 7 月 19 日：返抵桃園國際機場。

四、廠測內容

本次工廠測試於 103 年 7 月 13 日至 7 月 19 日由本總臺派員會同承商神通資科公司及系統製造商 SELEX 公司人員於德國杜塞爾多夫工廠進行。工廠測試內容係依據承商於 103 年 6 月 10 日提送總臺審閱之工廠測試程序，於測試過程中將測試結果逐項紀錄。

(一)、測試程序

依據工廠測試程序內容，共分為六大類內容說明如下：

1. General Information

- 敘述工廠測試(Factory Acceptance Test)進行的目的與預計達到的成果。

2. Verification of the IT system - Review of Design

- 確認執行 LLWAS 程式所需之硬體規格。

3. Verification of the Server Design and software

- 確認系統各項功能，包含 LLWAS 告警顯示、介面處理、資料重建等。

4. Verification of the LLWAS algorithm

- 確認機場相關資料，如跑道、測風塔位置等。

5. LLWAS data archive function test

- 確認 LLWAS 資料庫功能，可正確重建過往記錄，包含風向風速資料、歷史告警等。

6. NCAR comparison Test

- 驗證在相同氣象資料下，經由 SELEX 公司所建置的 LLWAS 系統顯示的 WSA 及 MBA 告警，與帶入 NCAR 演算法運算後所得結果相符。

(二)、測試環境說明

SELEX 公司以 2 部 HP 伺服器模擬桃園機場雙跑道運作之 LLWAS 伺服器工作情形，另以 1 部筆記型電腦模擬與伺服器連線之工作站。系統則以持續發生 MBA(微爆氣流) 告警之風速、風向資料，經 SELEX 公司依 NCAR 第三代低空風切告警系統運算；另有載入先前自總臺取得的桃園 AWOS 氣象觀測站資料作為顯示。



(三)、測試項目

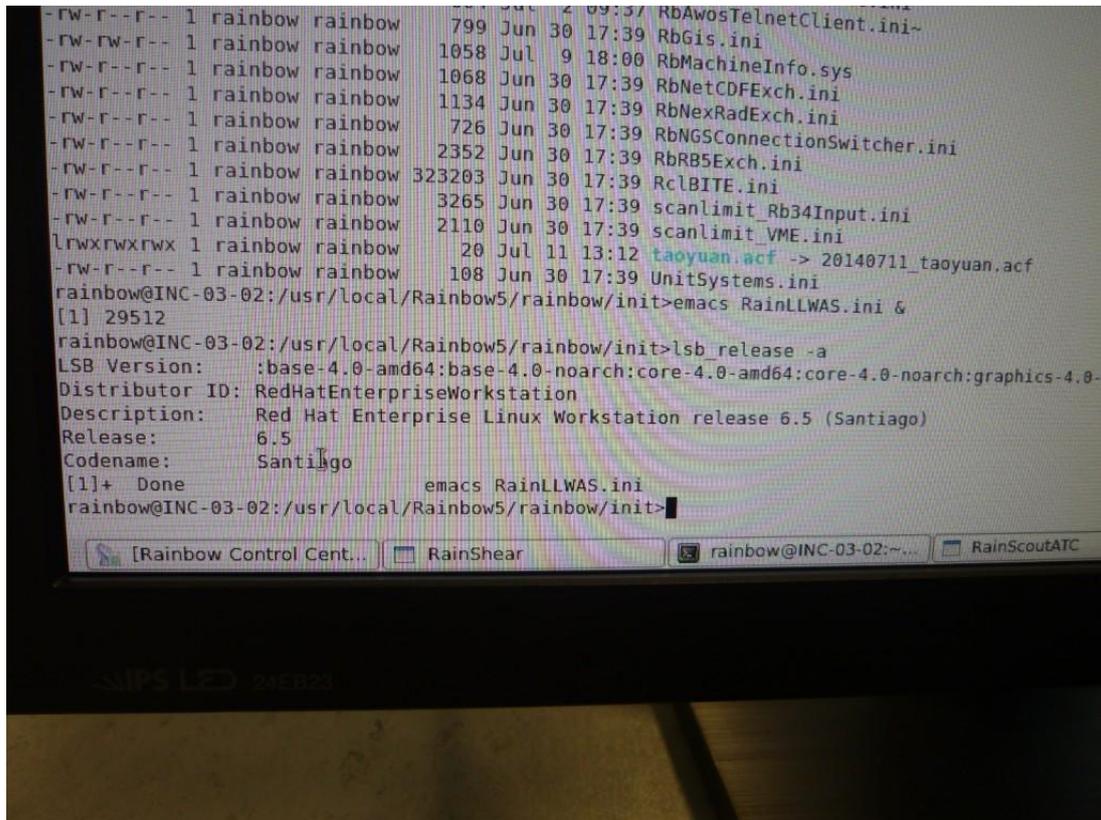
Step	Action	Expected Results	Check
3.1.2	Verify by review that a structural program technique is used.	The user identified a clear directory and file structure.	OK. 檢視其目錄及檔案結構。

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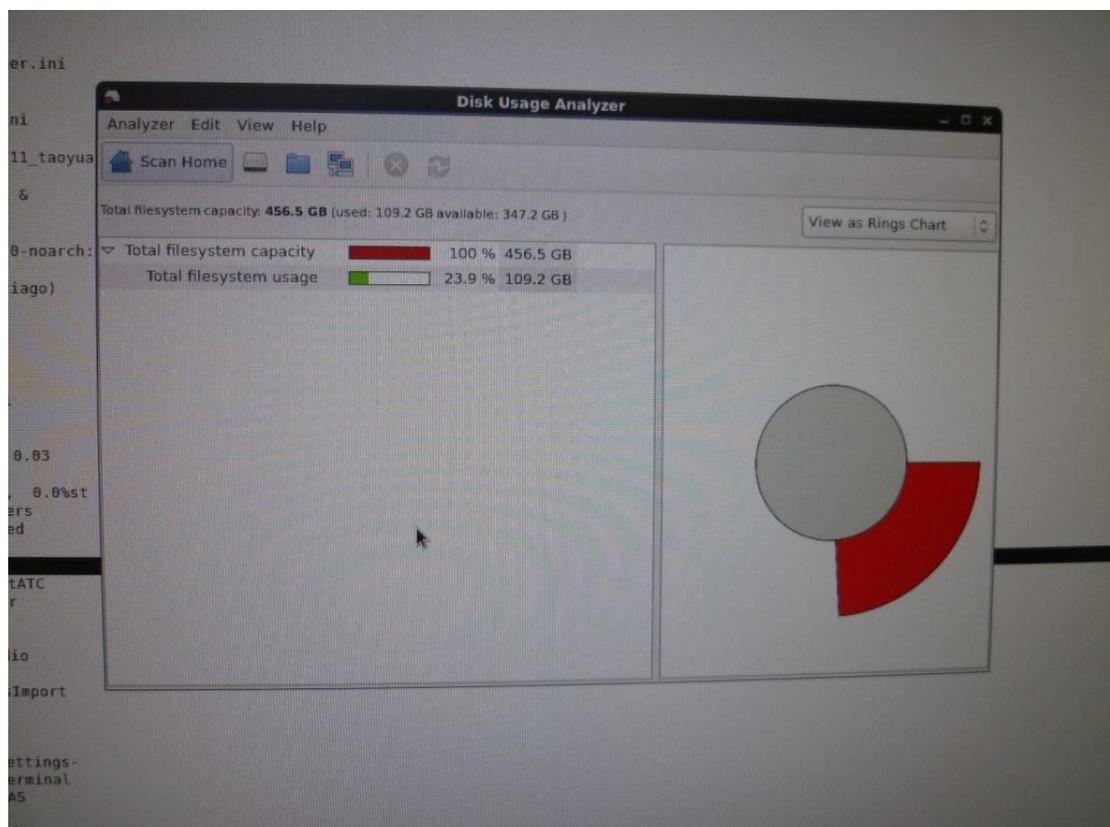
File Edit View Search Terminal Help
rainbow@INC-03-02:~/Desktop>cd /usr/local/Rainbow5/rainbow/
rainbow@INC-03-02:/usr/local/Rainbow5/rainbow>ls
AnemometerData  gisdata  map  scripts
AnemometerData.16  help  offline  scripts.initial
bin  htdocs  online  sdf
bin.initial  htdocs.initial  overlay  sensordata
cdf  icons  pdf  sounds
cmap  import  ppdf  task
current  init  ppython  tmp
debug  Initialize_RM.txt  python  tmp_ngs
defaultCDF  init.initial  rawdata  translations
defaultPDF  Landusemap  rb5input  wallpaper
defaultPPDF  lib  rclfiles.initial
defaultSDF  log  scheduler
rainbow@INC-03-02:/usr/local/Rainbow5/rainbow>ll
total 236
drwxrwxr-x 2 rainbow rainbow 12288 Jul 14 15:24 AnemometerData
drwxrwxr-x 2 rainbow rainbow 16384 Jul 9 17:29 AnemometerData.16
drwxr-xr-x 6 rainbow rainbow 4096 Jul 11 12:11 bin
drwxr-xr-x 2 rainbow rainbow 4096 Jul 3 15:22 bin.initial
drwxr-xr-x 5 rainbow rainbow 4096 Jul 2 02:00 cdf
drwxrwxr-x 2 rainbow rainbow 4096 Jun 30 18:09 cmap
drwxrwxr-x 2 rainbow rainbow 4096 Jun 30 18:09 current
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 debug
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 defaultCDF
drwxr-xr-x 3 rainbow rainbow 4096 Jul 2 02:00 defaultPDF
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 defaultPPDF
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 defaultSDF
drwxrwxr-x 5 rainbow rainbow 4096 Jun 18 18:45 gisdata
drwxrwxr-x 4 rainbow rainbow 4096 Jul 14 13:43 help
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 htdocs
drwxr-xr-x 3 rainbow rainbow 4096 Jul 2 02:00 htdocs.initial
drwxr-xr-x 5 rainbow rainbow 16384 Jul 2 02:00 icons
drwxrwxr-x 3 rainbow rainbow 4096 Jul 1 16:22 import
drwxr-xr-x 5 rainbow rainbow 4096 Jul 11 13:12 init
-rw-r--r-- 1 rainbow rainbow 1259 Jul 2 02:00 Initialize_RM.txt
drwxr-xr-x 5 rainbow rainbow 4096 Jul 2 02:00 init.initial
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 landusemap
drwxr-xr-x 4 rainbow rainbow 16384 Jul 2 02:33 lib
drwxr-xr-x 4 rainbow rainbow 12288 Jul 14 15:03 log
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 map
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 offline
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 online
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 overlay
drwxrwxr-x 3 rainbow rainbow 4096 Jun 30 18:09 pdf
drwxrwxr-x 3 rainbow rainbow 4096 Jun 30 18:09 ppdf
drwxrwxr-x 2 rainbow rainbow 4096 Jul 1 13:16 pref
drwxr-xr-x 3 rainbow rainbow 4096 Jul 11 12:16 python
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 rawdata
drwxrwxr-x 2 rainbow rainbow 4096 Jul 2 09:43 rb5input
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 rclfiles.initial
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 scheduler
drwxr-xr-x 2 rainbow rainbow 4096 Jul 11 12:16 scripts
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 scripts.initial
drwxrwxr-x 2 rainbow rainbow 4096 Jun 30 18:09 sdf
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 sensordata
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 sounds
drwxrwxr-x 3 rainbow rainbow 4096 Jun 30 18:09 task
drwxrwxr-x 3 rainbow rainbow 4096 Jul 14 15:24 tmp
drwxrwxr-x 2 rainbow rainbow 4096 Jun 30 18:09 tmp_ngs
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:33 translations
drwxr-xr-x 2 rainbow rainbow 4096 Jul 2 02:00 wallpaper
rainbow@INC-03-02:/usr/local/Rainbow5/rainbow>

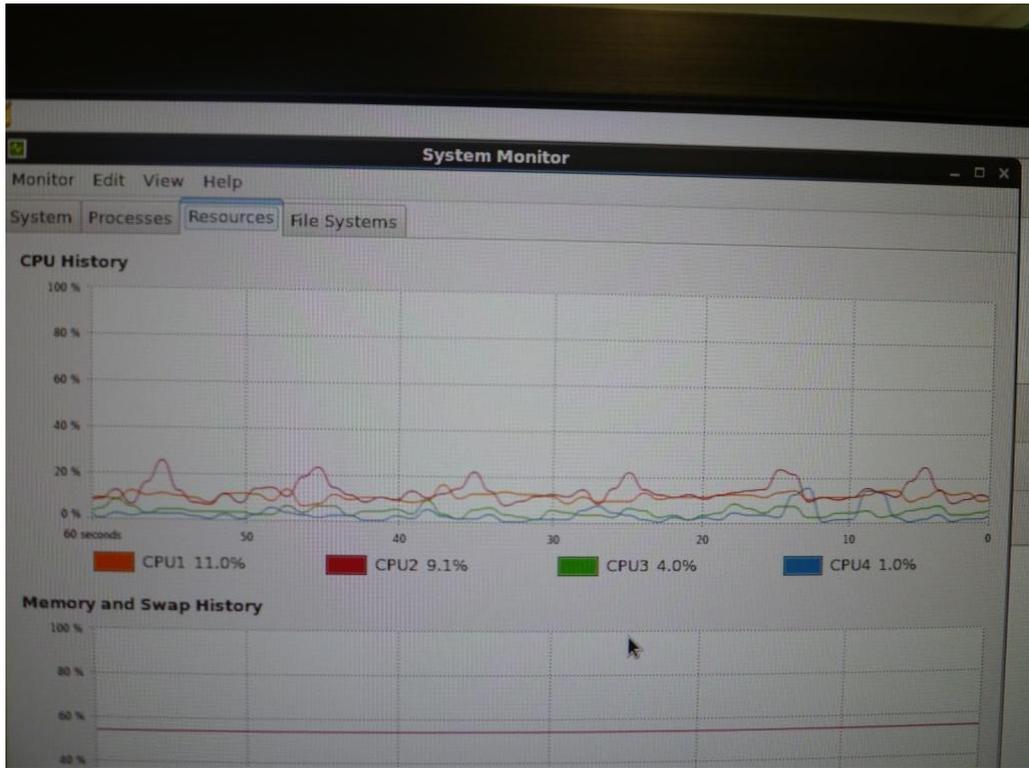
```

Step	Action	Expected Results	Check
3.1.3	<p>Verify by review software maintaining/reporting:</p> <p>Check if S/W is made in plain English.</p> <p>The Operating System is Linux Red Hat 6.x</p> <p>Check if S/W is operated and the data processes on Linux Red Hat system.</p>	<p>The user identified:</p> <p>The software language is English.</p> <p>The MS operates with Red Hat</p>	<p>OK.</p> <p>伺服器軟體版本: Red Hat 6.5</p>

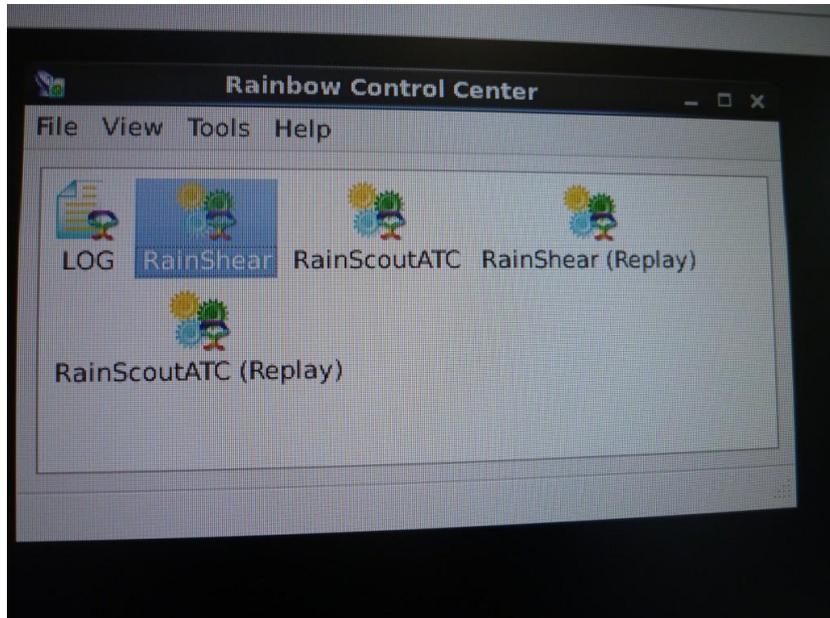


Step	Action	Expected Results	Check
3.1.5	Check the redundant server system mode “hot hot” . Simulate a breakdown of one MS.	The second system proceeds with the work. An alert should be generated.	於廠測現場MS1與MS2設定為「Hot-Hot」mode。檢視技術規範說明書2.2.1.3及2.2.1.4，MS1與MS2設定為「Hot-Hot」或「Hot-Standby」mode均符合部分需求，待返台後再行討論採用何種模式較佳，於功能測試(SAT)時再次驗證。
3.1.8	Verify by review that CPU operational load less than 50%, useage of memory is lower than 50% and HD space occupied right after the initial installation is lower than 50% of the total capacity.	The Req. is fulfilled.	OK. 於廠測現場，系統所佔硬碟容量僅23.9%、CPU使用率最高僅11%。惟應於功能測試(SAT)時再度檢測。

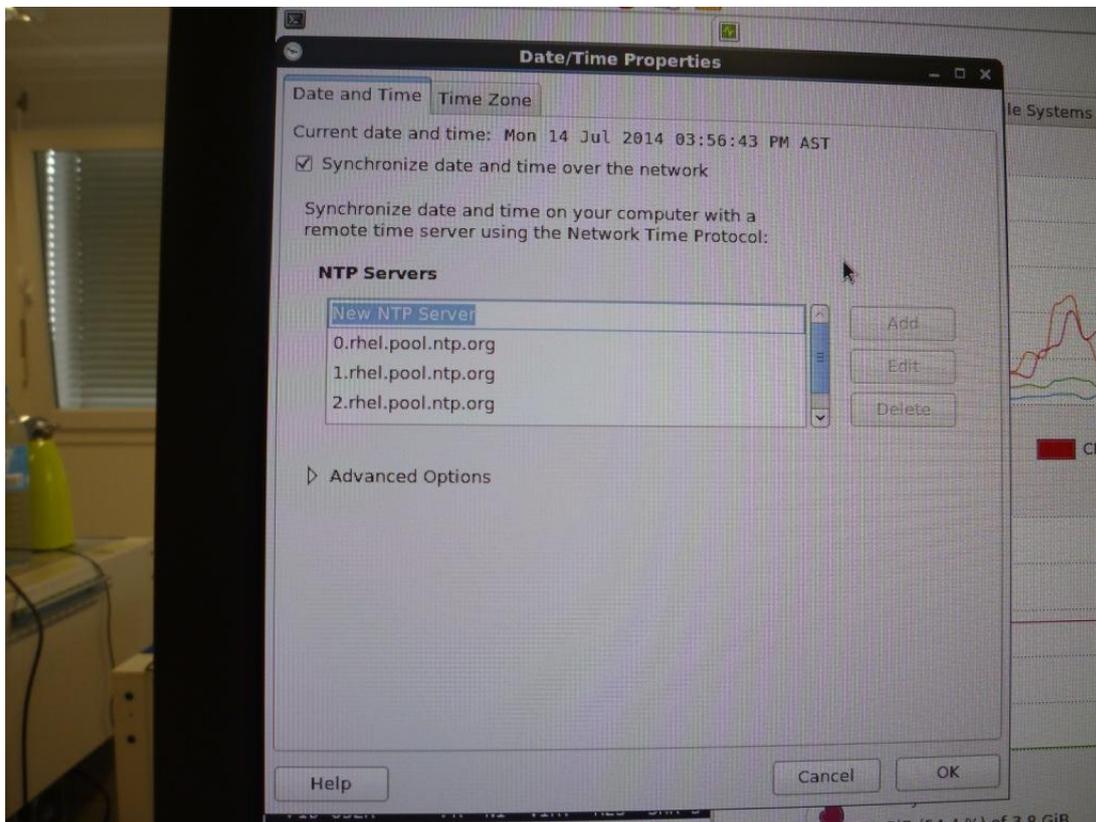




Step	Action	Expected Results	Check
3.2.2	Starting RainShear using the Icon	RainShear is open	OK. 可正確開啟程式。



Step	Action	Expected Results	Check
3.3.1	Verify by testing that operators are in the situation to set time on both systems. The time shall be displayed in line with network. The ShearScout/ LLWAS uses these applicable hours in storing files, maintaining and operating every other function.	Examine time setting function on both systems. Storing a file and examine the file name. The file name is stored using time provided by the servers (GPS time).	OK. 可經由網路校時，並可選擇網路校時的NTP Server。

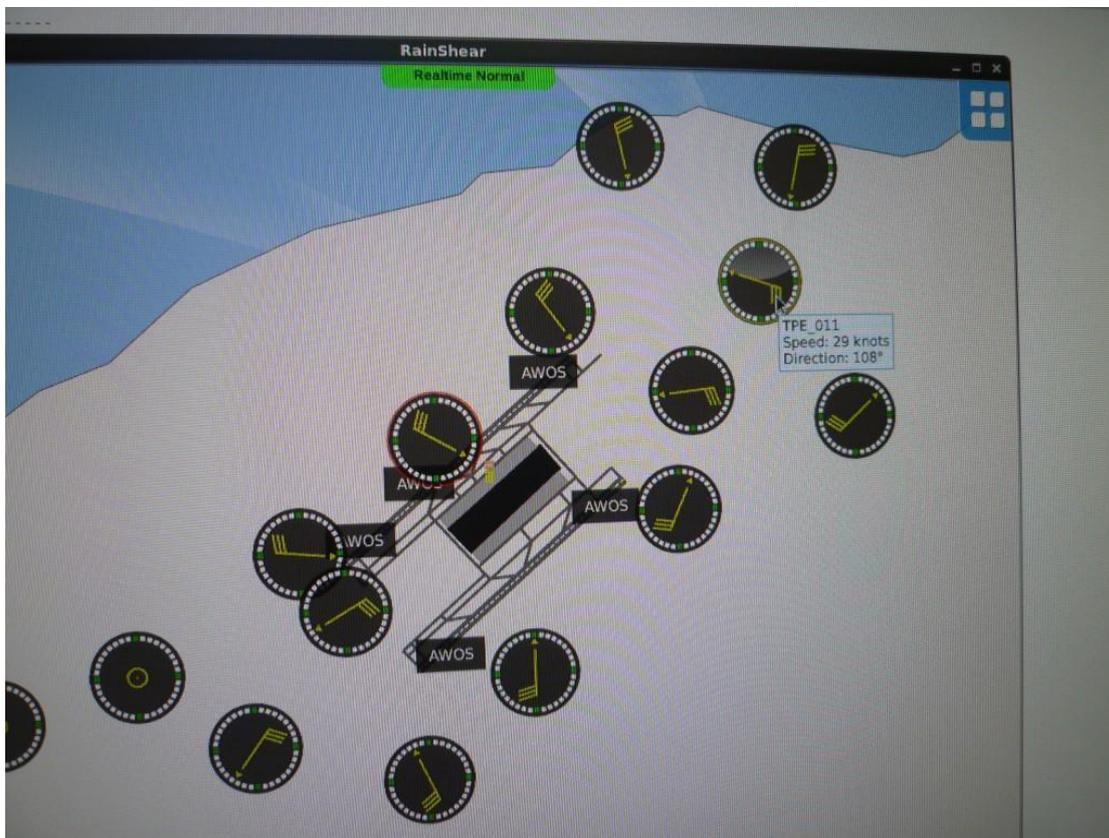


Step	Action	Expected Results	Check
3.3.3	Verify that MS is able to calculate the Network Mean	Examine the Network Mean Values.	OK. “Network Mean” 為測風站風速資料u、v之平均值。

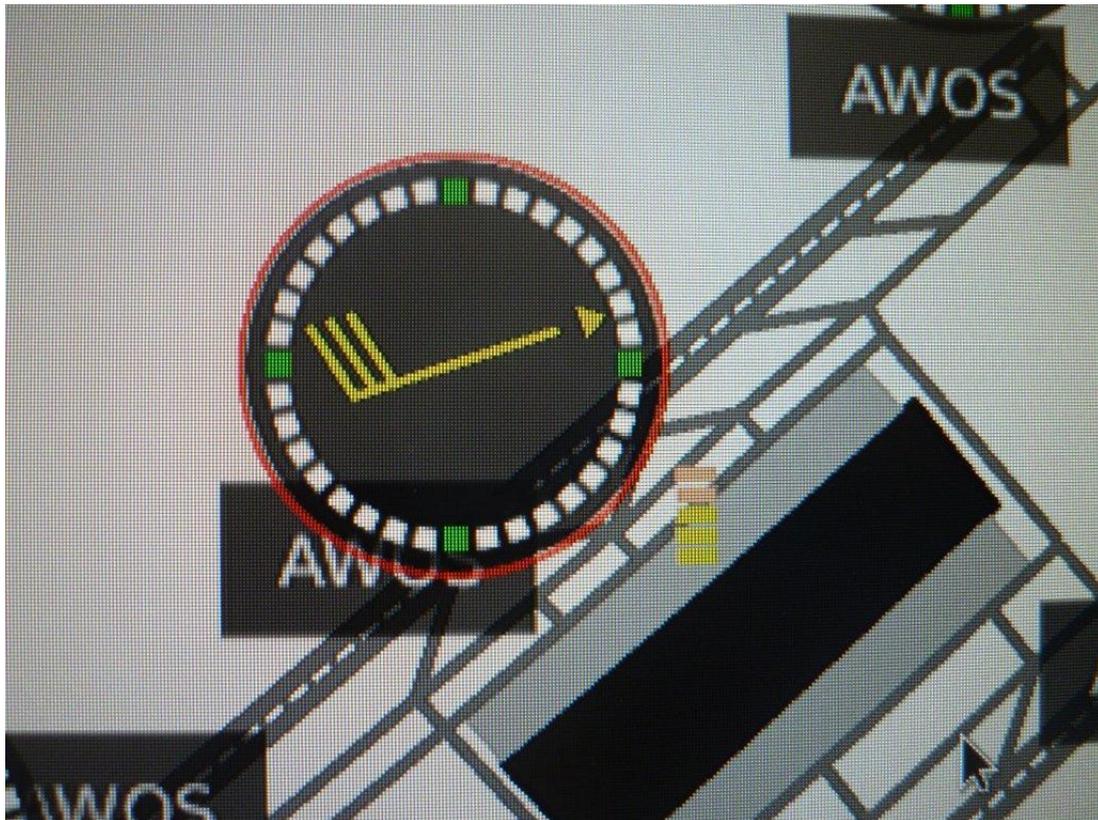
The screenshot displays the 'LLWAS-Reports Realtime' interface. At the top right, it indicates 'RainShear Realtime Normal' and has a 'View Settings' button. The main data is presented in a table with the following columns: Time, u, v, and Data. The 'Data' column consistently reports 'gust wind: 49 knots'. The 'u' and 'v' columns show wind speed components in m/s, ranging from -0.4 to 0.4. The 'Time' column shows timestamps from 2014-07-14 12:54:37 to 2014-07-14 12:59:17. On the left side of the screen, there is a terminal window showing system statistics such as CPU usage (93.9%), memory usage (85m S 9.3%), and other system metrics.

Time	u	v	Data
2014-07-14 12:59:17	-0.2 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:59:07	-0.3 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-14 12:58:57	-0.2 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:58:47	-0.1 m/s	0.0 m/s	gust wind: 49 knots
2014-07-14 12:58:37	-0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-14 12:58:27	-0.0 m/s	-0.4 m/s	gust wind: 49 knots
2014-07-14 12:58:17	-0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-14 12:58:07	-0.1 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:57:57	0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-14 12:57:47	0.3 m/s	-0.3 m/s	gust wind: 49 knots
2014-07-14 12:57:37	0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-14 12:57:27	-0.0 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:57:17	0.2 m/s	-0.0 m/s	gust wind: 49 knots
2014-07-14 12:57:07	0.4 m/s	0.0 m/s	gust wind: 49 knots
2014-07-14 12:56:57	0.2 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:56:47	0.1 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-14 12:56:37	0.1 m/s	0.1 m/s	gust wind: 49 knots
2014-07-14 12:56:27	0.2 m/s	0.3 m/s	gust wind: 49 knots
2014-07-14 12:56:17	0.2 m/s	0.2 m/s	gust wind: 49 knots
2014-07-14 12:56:07	0.1 m/s	0.0 m/s	gust wind: 49 knots
2014-07-14 12:55:57	0.0 m/s	0.2 m/s	gust wind: 49 knots
2014-07-14 12:55:47	-0.1 m/s	0.4 m/s	gust wind: 49 knots
2014-07-14 12:55:37	0.0 m/s	0.2 m/s	gust wind: 49 knots
2014-07-14 12:55:27	0.1 m/s	0.1 m/s	gust wind: 49 knots
2014-07-14 12:55:17	0.1 m/s	0.1 m/s	gust wind: 49 knots
2014-07-14 12:55:07	-0.3 m/s	0.2 m/s	gust wind: 49 knots
2014-07-14 12:54:57	-0.2 m/s	0.2 m/s	gust wind: 49 knots
2014-07-14 12:54:47	-0.0 m/s	0.1 m/s	gust wind: 49 knots
2014-07-14 12:54:37	-0.2 m/s	-0.0 m/s	gust wind: 49 knots
2014-07-14 12:54:27	-0.4 m/s	-0.1 m/s	gust wind: 49 knots

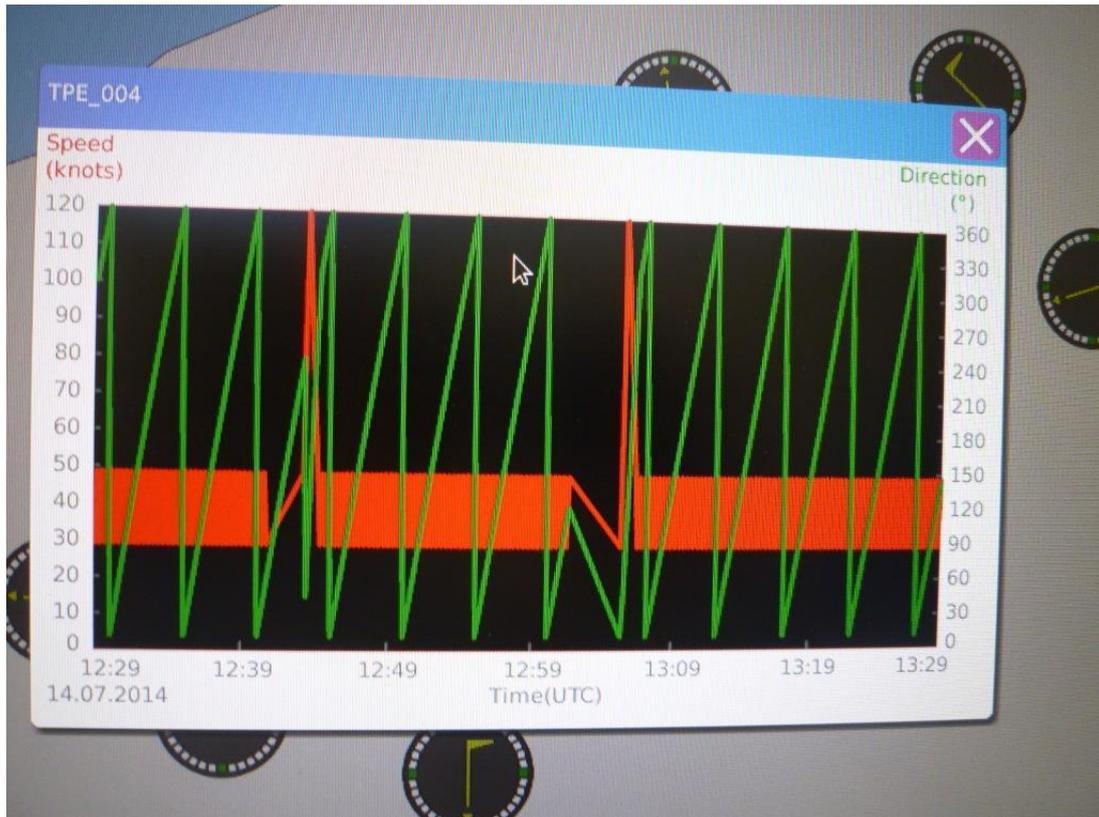
Step	Action	Expected Results	Check
3.4.3	<p>Check the LLWAS System status which will be indicated in RainShear:</p> <p>Real time normal (green)</p> <p>Real time degraded (yellow)</p> <p>System Support (red)</p> <p>Initialization (yellow)</p> <p>Off (red)</p>	<p>This status should indicate when all anemometers 16 deliver wind data.</p> <p>Some anemometers 15 - 14 break down but LLWAS still operating.</p> <p>To few anemometers out of order 13 the LLWAS is not able to operate</p> <p>The LLWAS will be initialized (e.g. after restart)</p> <p>No anemometers and also no RS status for more than n seconds.</p>	<p>OK.</p> <p>廠測時，模擬測風塔資料全部重啟後，隨測風塔資料陸續接入，系統狀態依序由” Support” →” Degraded” →” Normal” .</p>
3.4.4	Open the Wind-Situation Display (RWY underlay)	Wind-Situation Display window is open.	OK.
3.4.5	Verify by review that sensor information is shown on the Wind-Situation Display	Wind-Situation Display indicates wind sensor information (wind speed, wind direction or in case of break down the current status) of each anemometer.	<p>OK.</p> <p>當滑鼠移到該測風塔時，即會顯示該測風塔之風速、風向資料。</p>
3.4.6	Verify by review that the wind speed and directions are updated by each anemometer and displayed on the Wind-Situation Display	The wind parameters are updated every 10 seconds.	<p>OK.</p> <p>每10秒更新各測風塔風速風向資料。</p>



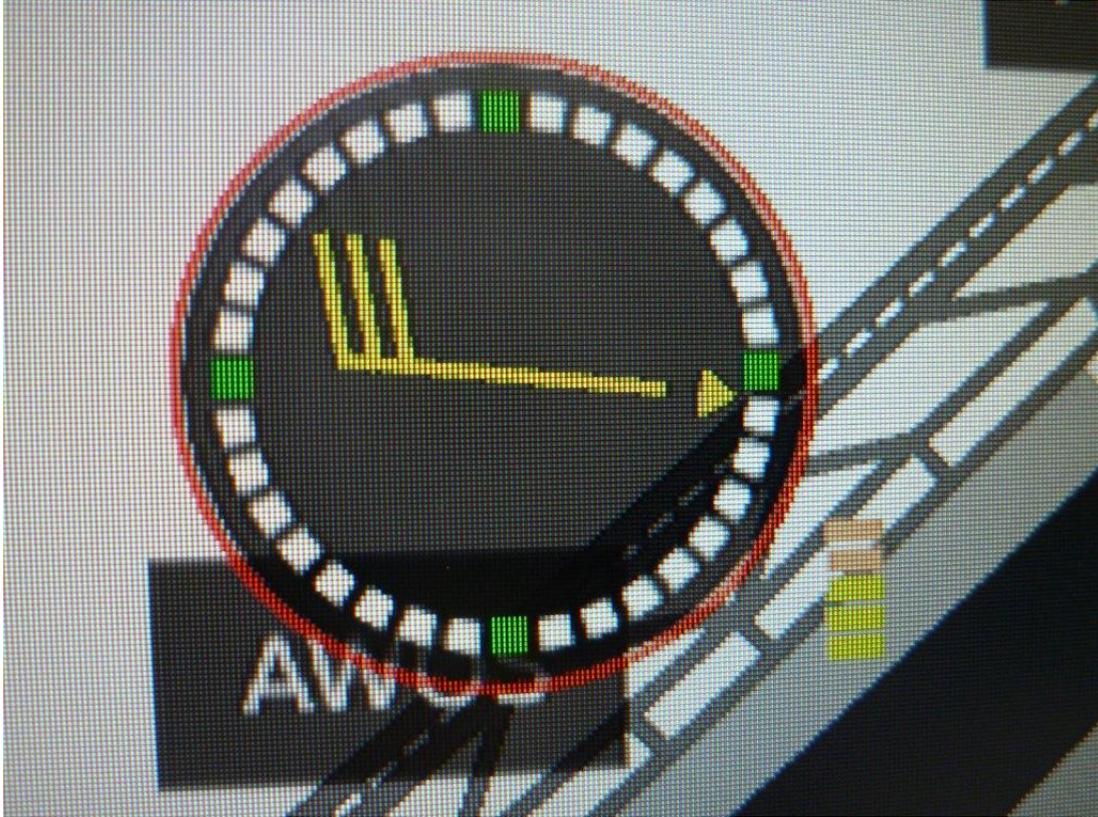
Step	Action	Expected Results	Check
3.4.7	Verify by review that in case of sensor breakdown the code "error" is displayed.	The "error" message is indicated of failed anemometer/s.	OK.
3.4.8	Verify by review that the centerfield sensor is indicated.	The centerfield sensor is displayed.	OK. 中場測風塔會以紅色外框標示。



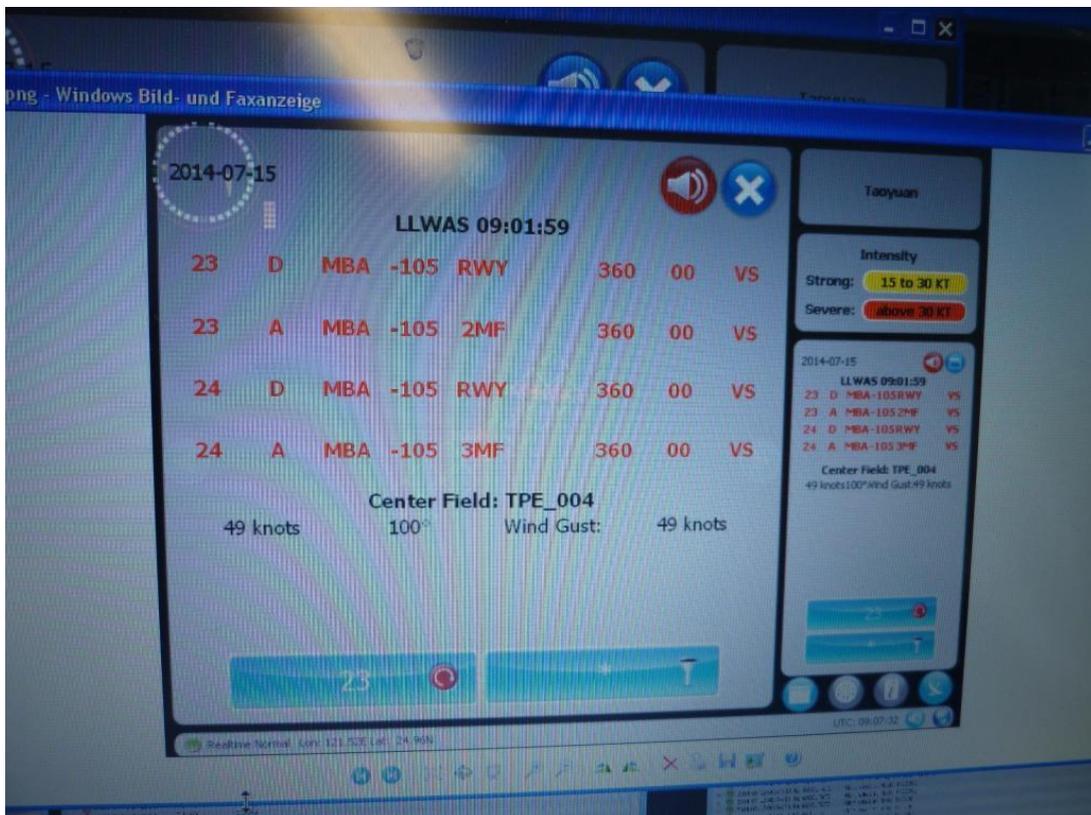
Step	Action	Expected Results	Check
3.4.9	Verify by test and click on any anemometer to display the temporal evolution of wind direction and wind velocity	An extra screen is displayed containing overview of wind direction and wind velocity.	OK. 以滑鼠點擊各測風塔，會跳出該測風塔的風速風向資料統計視窗。



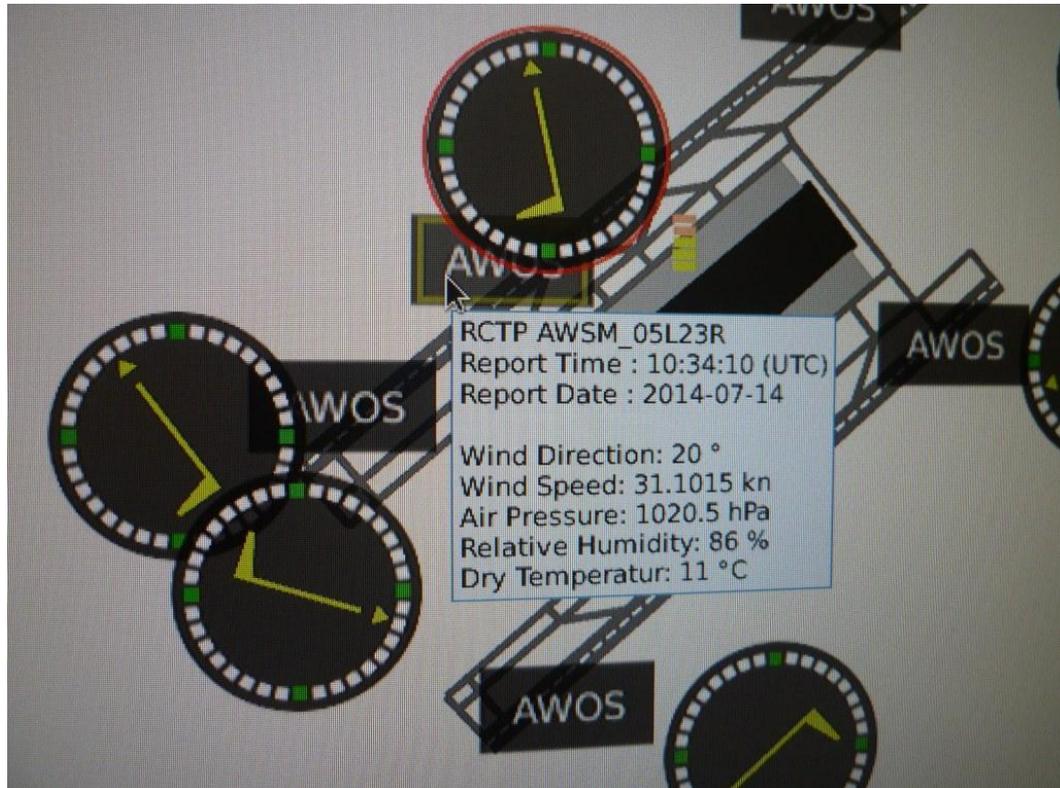
Step	Action	Expected Results	Check
3.4.10	Verify by review that the gust wind is displayed	Wind-Situation Display displays gust wind.	OK. 於中場測風塔右下角以五段顯示陣風資料。



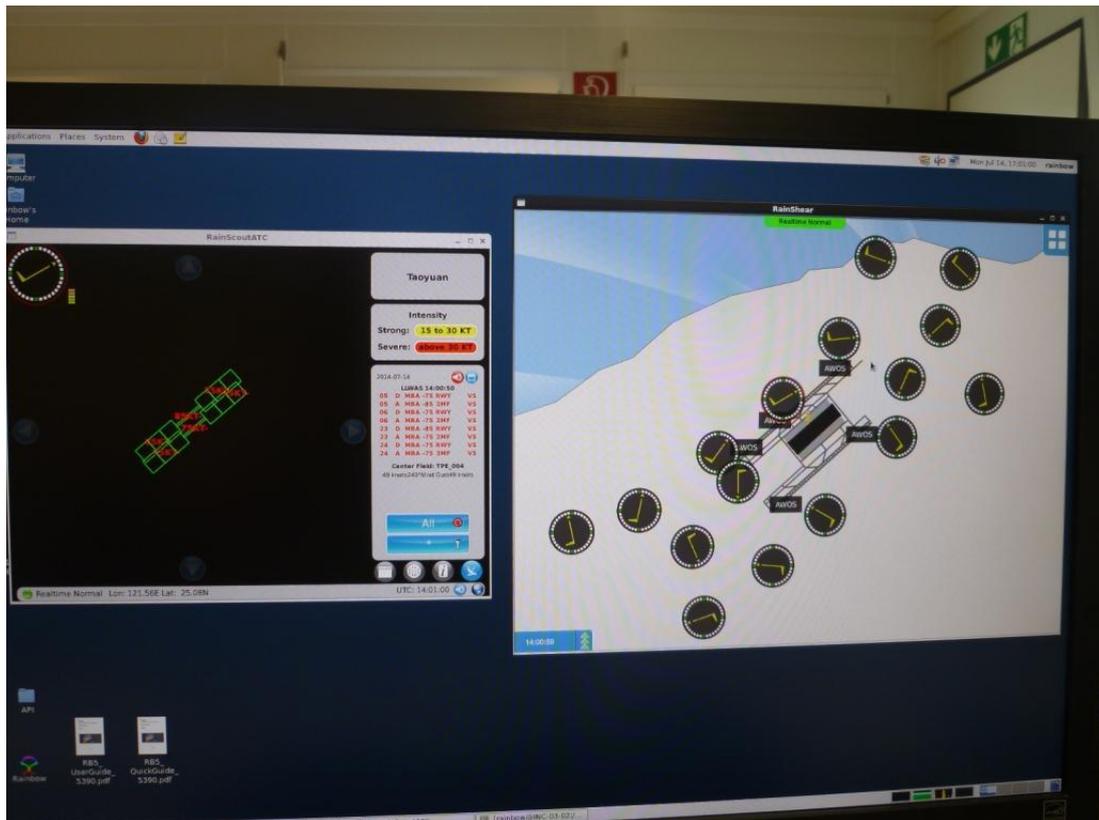
Step	Action	Expected Results	Check
3.4.11	Verify by review that the system is be able to access the wind speed and wind direction data in Buyer' s existing AWOS system (for Taoyan airport, it shall include data in the middle of runway) at both ends of runway, and display this numerical value on AAD and GAD.	The AWOS informations are displayed.	OK. AAD：顯示該跑道AWOS之風速及風向資料。 GAD：將配合” Wind-Situation Display”畫面一併顯示各測風站及AWOS陣地資料。



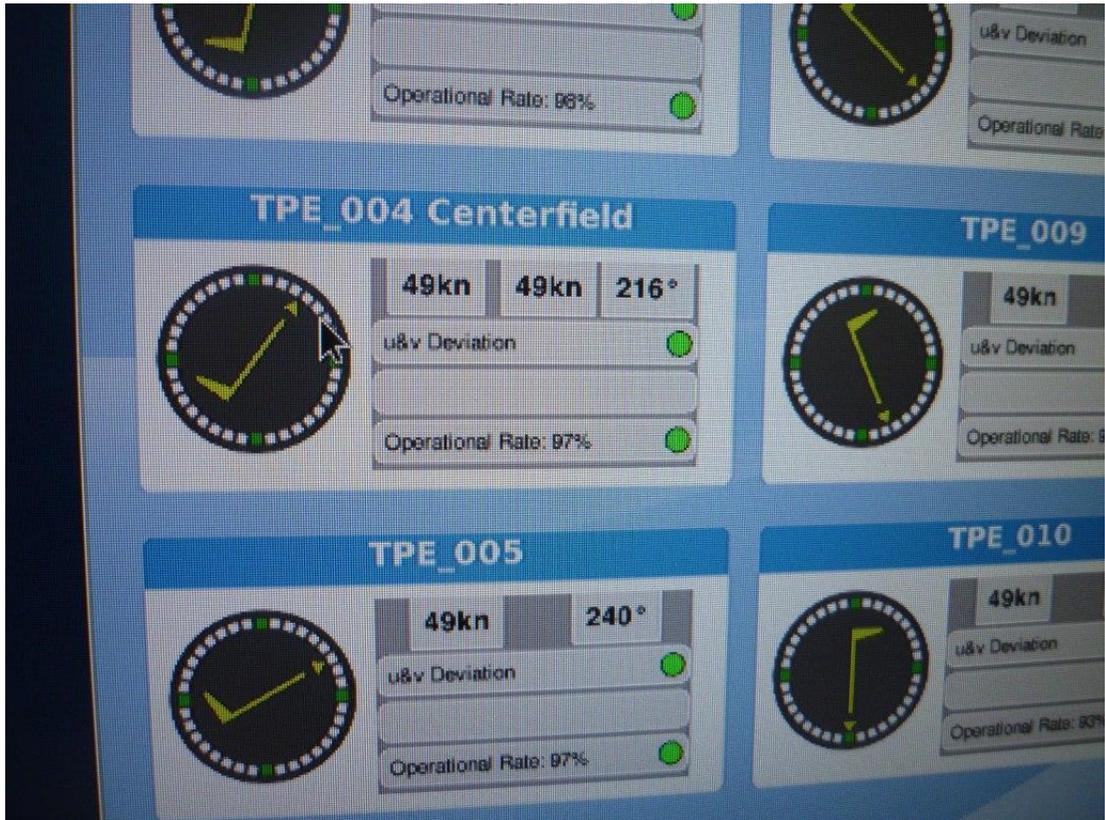
Step	Action	Expected Results	Check
3.4.12	Verify by review that users are able to read the AWOS information on the screen.	The AWOS information are displayed.	OK. 將滑鼠移至AWOS區塊上，將顯示該AWOS陣地測得之相關氣象資料。



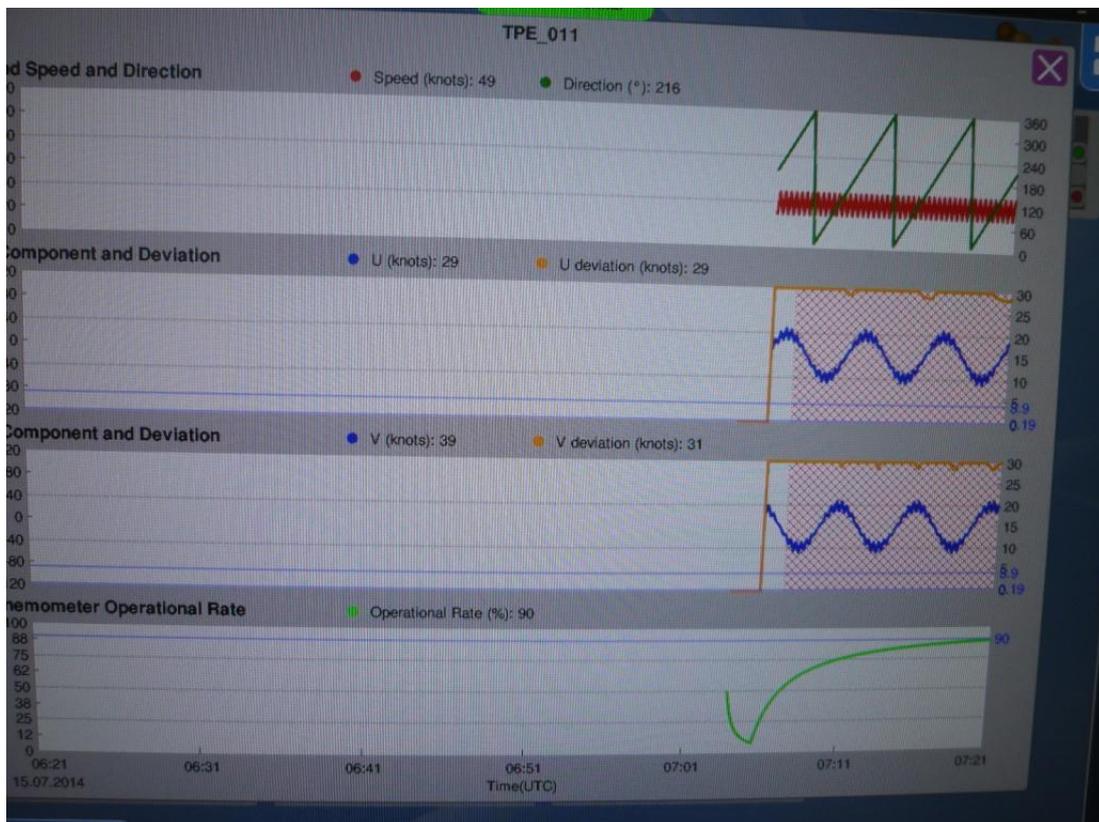
Step	Action	Expected Results	Check
3.4.13	All displayed windows for wind shear, wind data and AWOS information are displayed inside the same screen to easy operators operating.	The Req. is fulfilled.	OK. 風切告警及風場資料可於同畫面顯示。



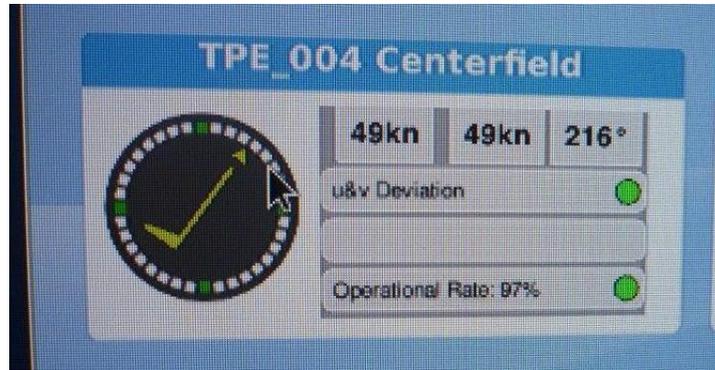
Step	Action	Expected Results	Check
3.4.14	Verify by review that the wind direction at the middle of airport is indicated by three digits from 001 to 360; the wind speed is indicated by two digits from 03 to 95 Knots, less than 3 Knots is indicated by CALM; the gust is indicated by two digits. If the maximum wind speed is greater than the previous of two minutes average, system should display it on screen.	The Req. is fulfilled.	因中場陣風為10分鐘統計所得，原廠提出需再確認NCAR演算法是為「2分鐘」或「10分鐘」平均。
3.4.15	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	OK.
3.4.16	Open the Maintenance Screen	Maintenance Screen window is open.	OK.
3.4.17	Verify by review that sensor information regarding speed and direction deviation and sensor status is shown on the Maintenance Screen	Maintenance Screen indicates wind sensor information (wind speed, wind direction deviation and status) of each anemometer	OK. 各測風塔之風速、風向資料顯示如下。



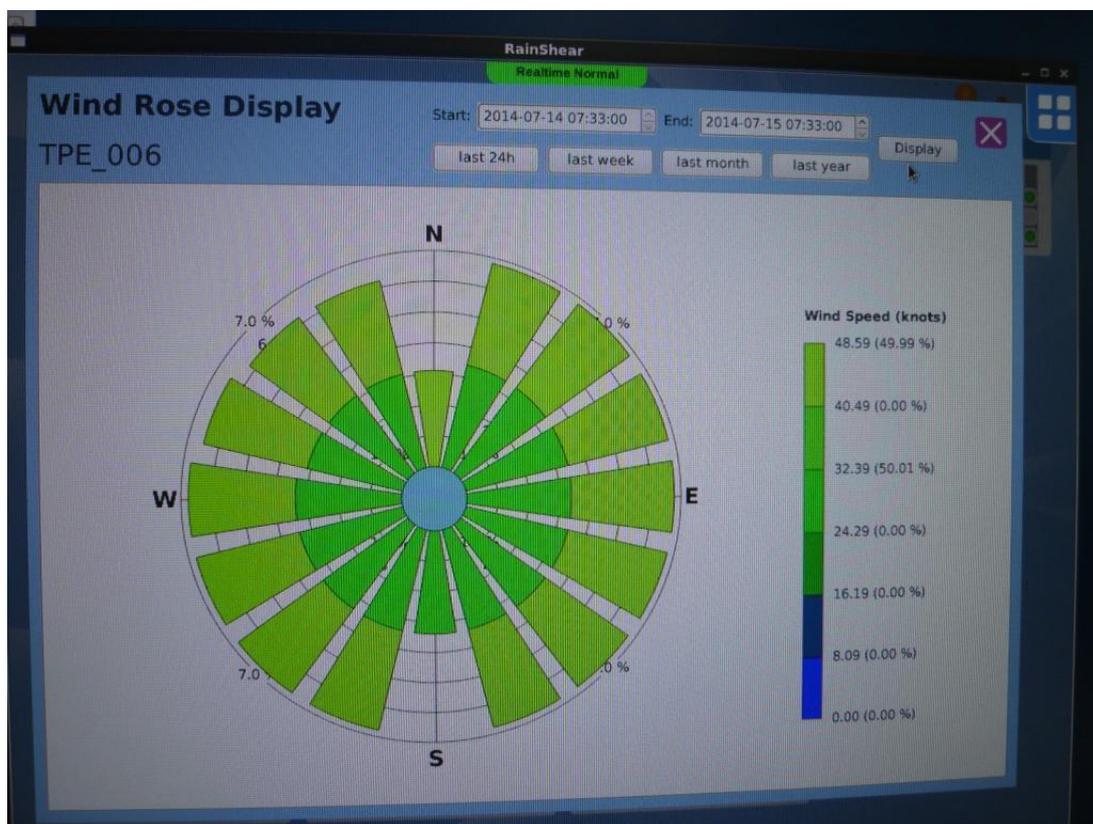
Step	Action	Expected Results	Check
3.4.18	Verify by review that the wind speed and directions deviation as well as sensor status is updated by each anemometer and displayed on the Maintenance Screen	The parameters are updated every 10 seconds.	OK. 每10秒風速風向均有更新。
3.4.19	Verify by review that in case of sensor breakdown the operational degradation is below threshold.	A warning is displayed.	OK. 根據NCAR演算法，u、v 超限後經過30sec才會顯示”error”。



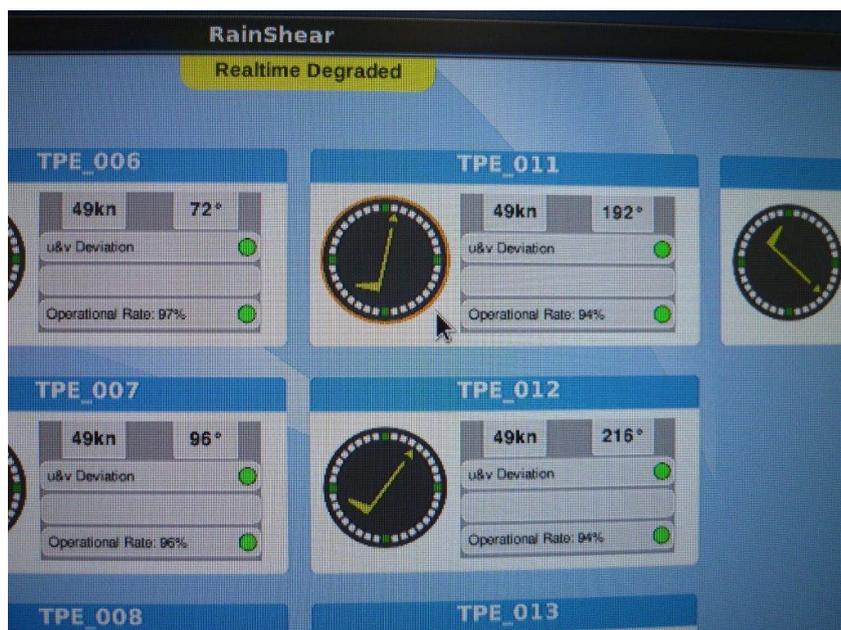
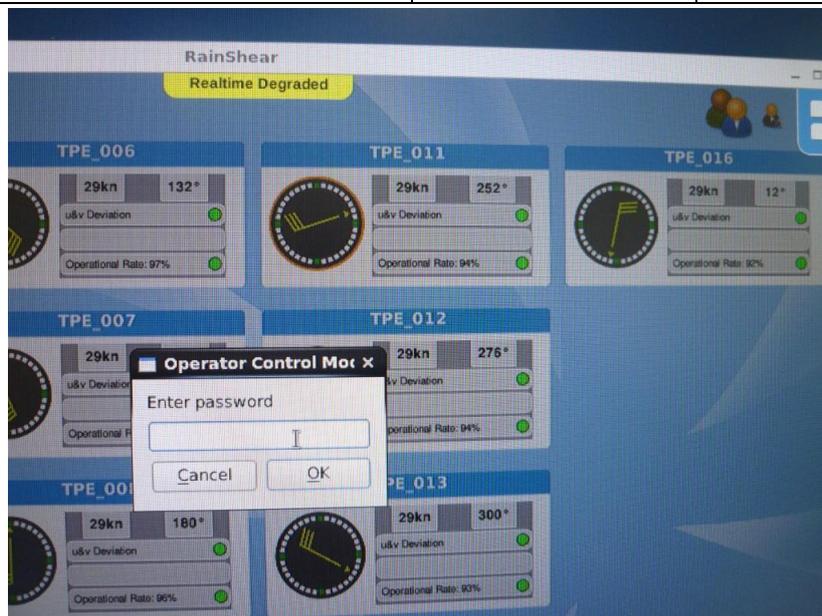
Step	Action	Expected Results	Check
3.4.20	Verify by review that the centerfield sensor is indicated.	The centerfield sensor is displayed.	OK. 中場測風塔可正確顯示為”Centerfield”。



Step	Action	Expected Results	Check
3.4.21	Verify by test: Click on any anemometer to display the temporal evolution of wind speed and direction deviation and operational degradation as well as the wind rose display and settings option functionality.	An extra screen is display can be opened to view the different functionalities.	OK. 風花圖如圖所示。



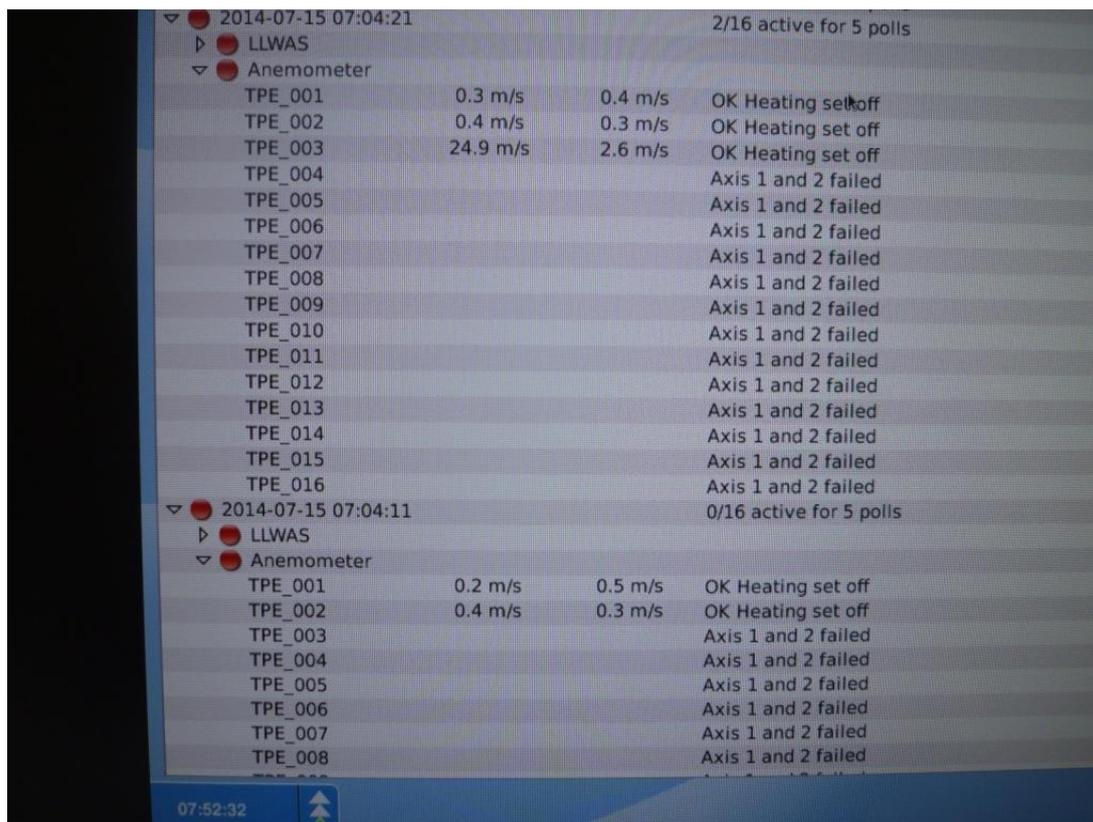
Step	Action	Expected Results	Check
3.4.22	Verify by testing the system can manually isolate the remote site from system calculation when its data becomes faulty or abnormal; however the speed and direction data shall still be shown. The operator can manually accept the sensor and include it in calculation once it has recovered.	The sensor can be isolated.	OK. 輸入管理者密碼後，可控制各測風塔是否隔離/納入 LLWAS 運算。 將#11測風塔隔離後，仍可持續接收風速風向之u與v資料。



Step	Action	Expected Results	Check
3.4.24	<p>Verify by testing that the maintenance screen is able to display wind speed, wind direction and measured the average wind speed and wind direction in system of each anemometer, and can be showed in tabular form.</p> <p>Verify by testing that the maintenance screen is able to display the wind rose drawing of each anemometer, and each one of the wind rose drawing can be selected by quarter, month, day, or by specifying the time interval screening.</p> <p>According to selected sites and counted by quarter, month, day, or by specifying the time interval to filter out and display wind shear data, and can show them in tabular format.</p>	The Req. is fulfilled.	<p>OK. 各測風塔資料可於” LLWAS Report” 頁面以列表方式呈現。</p> <p>如風花圖所示。</p> <p>可於” LLWAS Report” 之資料庫選擇「時段」、「日」、「月」方式顯示。</p>

Time	Wind Speed 1 (m/s)	Wind Speed 2 (m/s)	Gust Wind (knots)
2014-07-15 07:41:31	0.2	0.1	49
2014-07-15 07:41:21	0.1	-0.1	49
2014-07-15 07:41:11	0.1	0.2	49
2014-07-15 07:41:01	0.1	0.4	49
2014-07-15 07:40:51	0.1	0.2	49
2014-07-15 07:40:41	0.1	0.1	49
LLWAS			
Anemometer			
TPE_001	18.6	-16.7	OK Heating set off
TPE_002	10.2	-22.8	OK Heating set off
TPE_003	0.0	-25.0	OK Heating set off
TPE_004	-10.1	-22.9	OK Heating set off (Centerfield)
TPE_005	-18.6	-16.8	OK Heating set off
TPE_006	-23.8	-7.8	OK Heating set off
TPE_007	-24.9	2.6	OK Heating set off
TPE_008	-21.7	12.5	OK Heating set off
TPE_009	-14.7	20.2	OK Heating set off
TPE_010	-5.2	24.4	OK Heating set off
TPE_011	5.2	24.5	OK Heating set off
TPE_012	14.7	20.2	OK Heating set off
TPE_013	21.6	12.5	OK Heating set off
TPE_014	24.9	2.7	OK Heating set off
TPE_015	23.8	-7.7	OK Heating set off
TPE_016	18.6	-16.7	OK Heating set off
2014-07-15 07:40:31	-0.1	0.2	49
2014-07-15 07:40:21	-0.2	0.3	49
2014-07-15 07:40:11	-0.1	0.2	49
2014-07-15 07:40:01	0.0	0.1	49
2014-07-15 07:39:51	-0.2	0.1	49
2014-07-15 07:39:41	-0.4	0.1	49

Step	Action	Expected Results	Check
3.4.25	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	OK.
3.4.26	Verify by review that out of service time of anemometers are recorded.	The out of service time is recorded.	OK. LLWAS-Report每隔10秒會記錄各測風塔連線狀況。
3.4.29	Verify by review that in case of anemometers break down an alert will be indicated(visual red sign).	A red point indicates an anemometer error.	OK. 測風塔異常時，將有紅點標示
3.4.30	Verify by review that in case of anemometers break down the failed sensor will be indicated.	The failed anemometer is displayed.	OK.

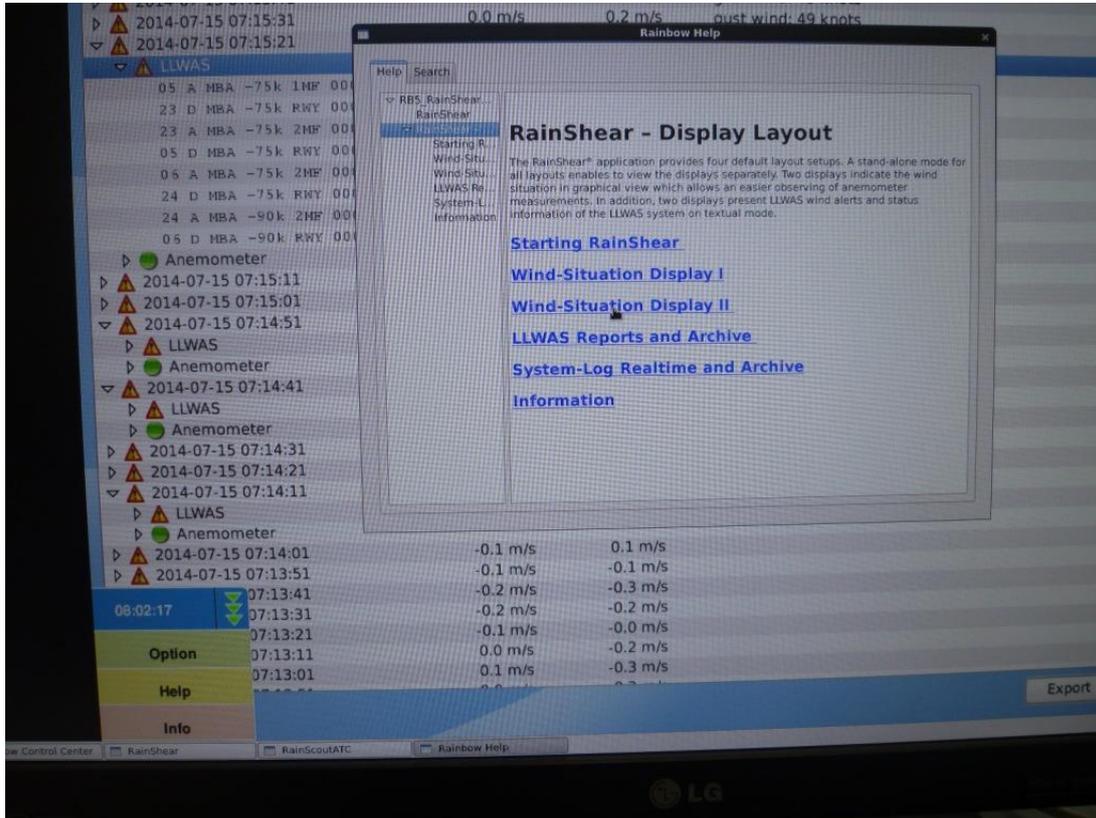


Step	Action	Expected Results	Check
3.4.27	Open the LLWAS report screen.	The LLWAS report screen is open.	OK.
3.4.28	Check that all anemometers and wind measurements are displayed on textual basis and the Network Mean is calculated.	All installed anemometers displaying wind information.	OK 各測風塔之平均 u、v均有顯示。
3.4.31	Verify by review that wind shear alerts are displayed(textual basis). The alerts has to specify: WindShear - Loss/Gain Microburst - Loss Location on RWY	A warning triangle is displayed when an alert is generated. A click on the triangle and the alert is specified according to LLWAS Phase 3 requirements.	MBA(微爆氣流告警) OK. WSA(風切告警)於工廠測試時未建模擬資料，故需於功能測試時再次驗證。

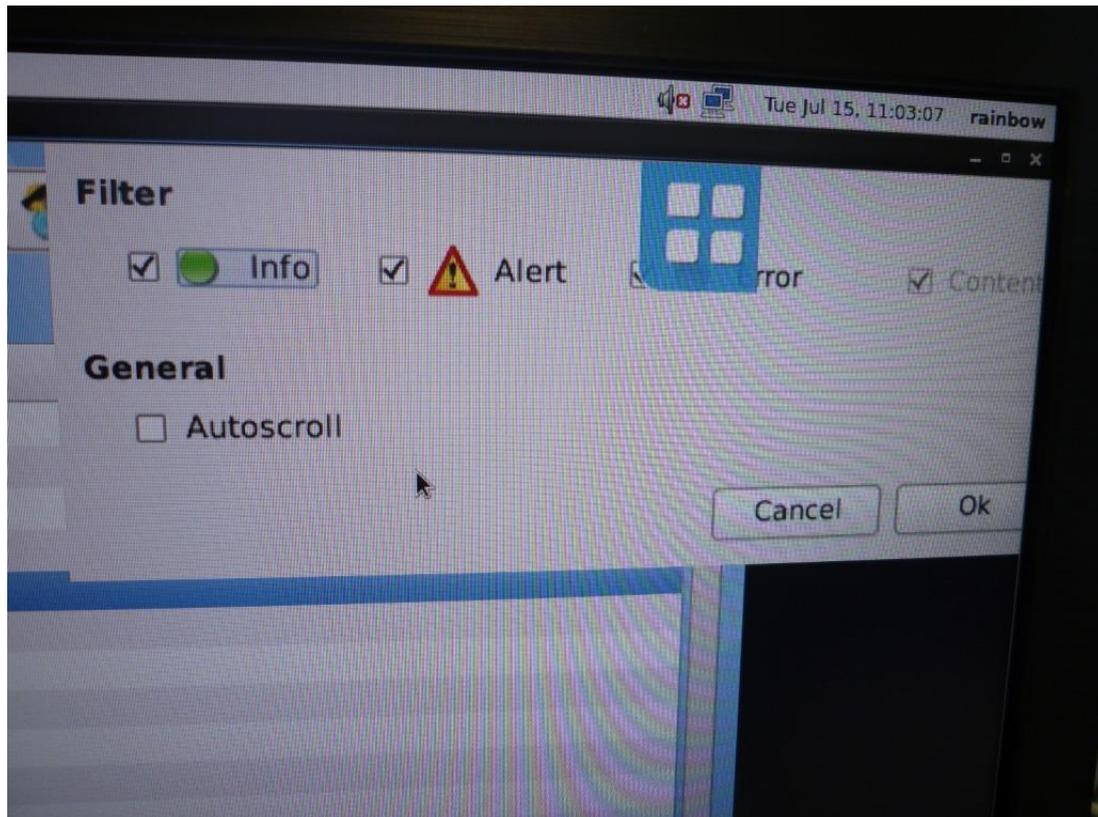
The screenshot displays the 'LLWAS-Reports Realtime' interface. At the top, it shows 'Rainshear Reason Normal' and a 'View Settings' button. The main content is a table with columns for 'Time', 'u', 'v', and 'Data'. The table is expanded to show 'LLWAS' alerts and 'Anemometer' data for various TPE units.

Time	u	v	Data
2014-07-15 07:12:51	0.0 m/s	-0.2 m/s	
LLWAS			
05 A MBA -90k 3MF 000 00			
23 D MBA -90k RWY 000 00			
23 A MBA -85k 2MF 000 00			
05 D MBA -85k RWY 000 00			
06 A MBA -90k 3MF 000 00			
24 D MBA -90k RWY 000 00			
24 A MBA -85k 3MF 000 00			
06 D MBA -85k RWY 000 00			
Anemometer			
TPE_001	-0.5 m/s	0.2 m/s	OK Heating set off
TPE_002	-0.4 m/s	0.3 m/s	OK Heating set off
TPE_003	-6.1 m/s	13.7 m/s	OK Heating set off
TPE_004	-0.0 m/s	15.0 m/s	OK Heating set off
TPE_005	6.1 m/s	13.7 m/s	OK Heating set off
TPE_006	11.1 m/s	10.0 m/s	OK Heating set off
TPE_007	14.3 m/s	4.6 m/s	OK Heating set off
TPE_008	14.9 m/s	-1.6 m/s	OK Heating set off
TPE_009	13.0 m/s	-7.5 m/s	OK Heating set off
TPE_010	8.8 m/s	-12.1 m/s	OK Heating set off
TPE_011	3.1 m/s	-14.7 m/s	OK Heating set off
TPE_012	-3.1 m/s	-14.7 m/s	OK Heating set off
TPE_013	-8.8 m/s	-12.1 m/s	OK Heating set off
TPE_014	-13.0 m/s	-7.5 m/s	OK Heating set off
TPE_015	-14.9 m/s	-1.6 m/s	OK Heating set off
TPE_016	-14.3 m/s	4.6 m/s	OK Heating set off
2014-07-15 07:12:41	-0.1 m/s	-0.1 m/s	
2014-07-15 07:12:31	0.2 m/s	-0.1 m/s	
07:12:21	0.4 m/s	-0.1 m/s	
07:12:11	0.2 m/s	-0.1 m/s	

Step	Action	Expected Results	Check
3.4.32	Check the Online Help function Using the corresponding symbol inside RainShear Display	The Rainbow Software Online Help is available	OK. 有” Online Help” 功能。



Step	Action	Expected Results	Check
3.4.33	Check the setting function to filter results to be visualised. - Anemometer Errors - Wind Shear Alerts - Normal conditions - All	The filter function works on required performance.	OK. SELEX公司承諾將更改圖層設定，使字不會被擋到。

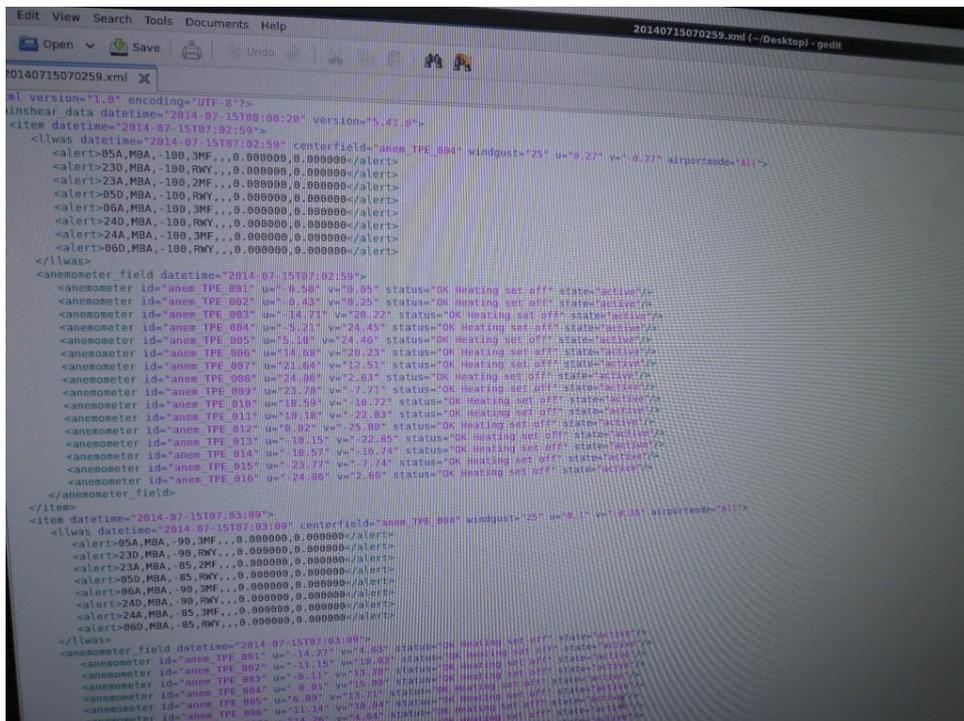
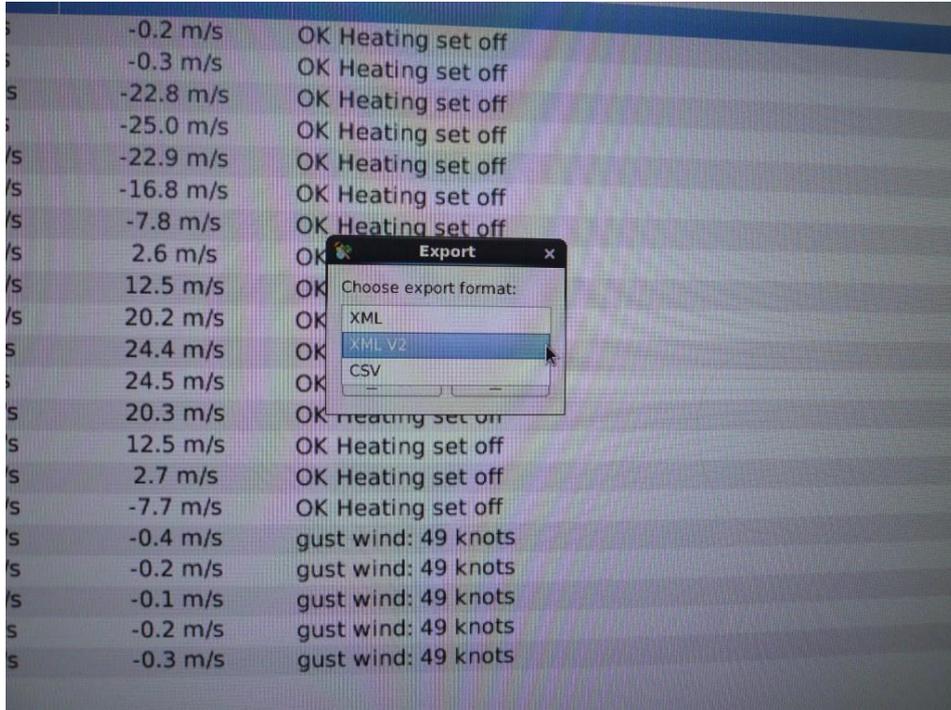


Step	Action	Expected Results	Check
3.4.34	Check the data archive function (click on database icon) for anemometer data and wind shear alerts. - select start and end time - start data request	Within the selected time frame all data can be visualized.	OK. 資料庫內容(歷史告警)可被正確顯示。
3.4.37	Verify by review that System Cycle time of the server in main station is less than 10 seconds including first gets the wind speed and direction from the remote anemometer, processes, produces the shear/microburst/burst alert, finally shows the situation on the workstations and records it in the database.	The system cycle is 10 sec.	OK. 自接收資料、運算、顯示告警可於10秒內完成。

The screenshot shows the 'LLWAS-Reports Archive' web interface. It includes a search bar with 'Start: 2014-07-15 07:02:58' and 'Stop: 2014-07-15 07:03:58'. The main data table is as follows:

Time	u	v	Data
2014-07-15 07:03:51			0/16 active for 5 polls gust wind: 49 knots
2014-07-15 07:03:49	-0.0 m/s	-0.2 m/s	0/16 active for 5 polls
2014-07-15 07:03:41			0/16 active for 5 polls
LLWAS			
Anemometer			
TPE_001	0.5 m/s	-0.2 m/s	OK Heating set off
TPE_002	0.4 m/s	-0.3 m/s	OK Heating set off
TPE_003	10.2 m/s	-22.8 m/s	OK Heating set off
TPE_004	0.1 m/s	-25.0 m/s	OK Heating set off
TPE_005	-10.1 m/s	-22.9 m/s	OK Heating set off
TPE_006	-18.5 m/s	-16.8 m/s	OK Heating set off
TPE_007	-23.8 m/s	-7.8 m/s	OK Heating set off
TPE_008	-24.9 m/s	2.6 m/s	OK Heating set off
TPE_009	-21.7 m/s	12.5 m/s	OK Heating set off
TPE_010	-14.7 m/s	20.2 m/s	OK Heating set off
TPE_011	-5.3 m/s	24.4 m/s	OK Heating set off
TPE_012	5.1 m/s	24.5 m/s	OK Heating set off
TPE_013	14.6 m/s	20.3 m/s	OK Heating set off
TPE_014	21.6 m/s	12.5 m/s	OK Heating set off
TPE_015	24.9 m/s	2.7 m/s	OK Heating set off
TPE_016	23.8 m/s	-7.7 m/s	OK Heating set off
2014-07-15 07:03:39	-0.0 m/s	-0.4 m/s	gust wind: 49 knots
2014-07-15 07:03:29	-0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-15 07:03:19	-0.1 m/s	-0.1 m/s	gust wind: 49 knots
2014-07-15 07:03:09	0.1 m/s	-0.2 m/s	gust wind: 49 knots
2014-07-15 07:02:59	0.3 m/s	-0.3 m/s	gust wind: 49 knots

Step	Action	Expected Results	Check
3.4.35	Check the export function (click on button export) to export displayed data into an external XML file	Data are exported into an external file.	OK. 系統告警及資料可輸出為”XML”、”XML V2”及”CSV”等格式。



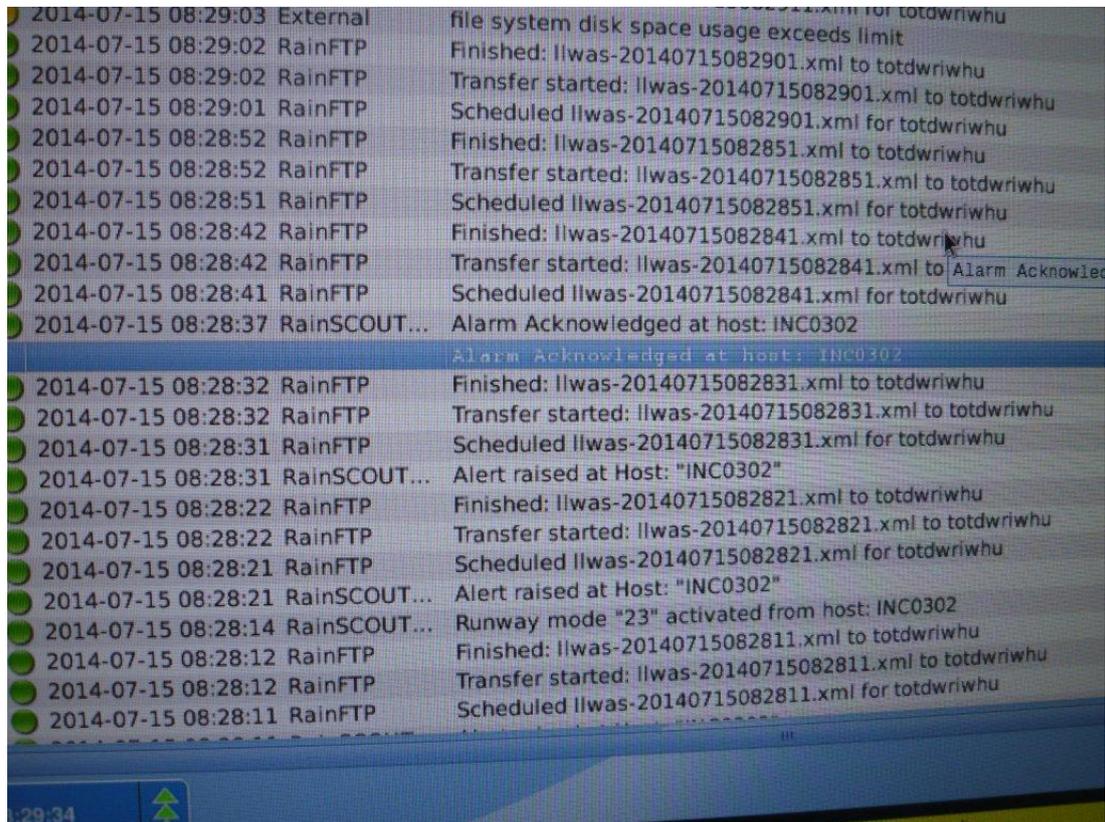
Step	Action	Expected Results	Check
3.4.36	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	OK.
3.4.38	Open the System-log screen.	The System-log screen is open.	OK.
3.4.39	Verify be review that in case of status "System Support" a log-message will be shown and stored.	The log-message is stored accordingly.	OK.
3.4.40	<p>RainShear Status Update (RainRCS) - indicates the status of the server system.</p> <p>Verify by review that in case of a RainRCS process is not running a message will be indicated. A click to RainRCS and it is indicated which process is 'Down'. The following processes are shown:</p> <ol style="list-style-type: none"> 1. <i>NGS</i> 2. <i>RainRLS</i> 3. <i>RainAdmin</i> 4. <i>RainDbAdmin</i> 5. <i>mometerEmitter</i> 6. <i>RainDTCim</i> 7. <i>RainLLWAS</i> 8. <i>EmomoterImport</i> 	Indicates Up/Down	<p>OK.</p> <p>RainShear伺服器狀態可正確顯示。點開後有詳細資料（包含：執行程序、目前狀態、開始執行時間等等）顯示。</p>

Time	Application	Text
2014-07-15 08:24:40	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:24:30	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:24:20	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:24:10	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:24:00	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:50	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:49	RainRCS	RainRCS status update:
<pre> RainRCS status report: 2014-07-15 08:23:49 Version: 5.41.0 Standby mode: Standalone Database status report Database is not configured. Nr Status Since Reat. Process Parameter ----- 1 Up 07-14 12:43 0 NGS -XX:-UseSplitVerifier -Xms40m -Xmx180m - ... 2 Up 07-14 12:43 0 RainRLS 3 Up 07-14 12:43 0 PostgreSQL -rundb -maintain 4 Up 07-14 12:43 0 RainADMIN 5 Up 07-14 12:43 0 RainAnomImport --fake-dates yes 6 Up 07-14 12:43 0 AnemometerImport -host=127.0.0.1 -port=7019 -airport=TPB ... 7 Up 07-15 08:49 0 RainLLNAS -acf=init/taoyuan.acf -airport=TPB -ms=0 8 Up 07-14 12:43 0 RainDTCSin -port=7019 -data=AnemometerData -type=LS ... 9 Up 07-14 12:43 0 elnetServer.py 10 Up 07-14 12:43 0 elnetCLI </pre>		
2014-07-15 08:23:40	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:30	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:20	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:10	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:23:00	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:22:50	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:22:40	RainSCOUT...	Alert raised at Host: "INC0301"
2014-07-15 08:22:30	RainSCOUT...	Alert raised at Host: "INC0301"

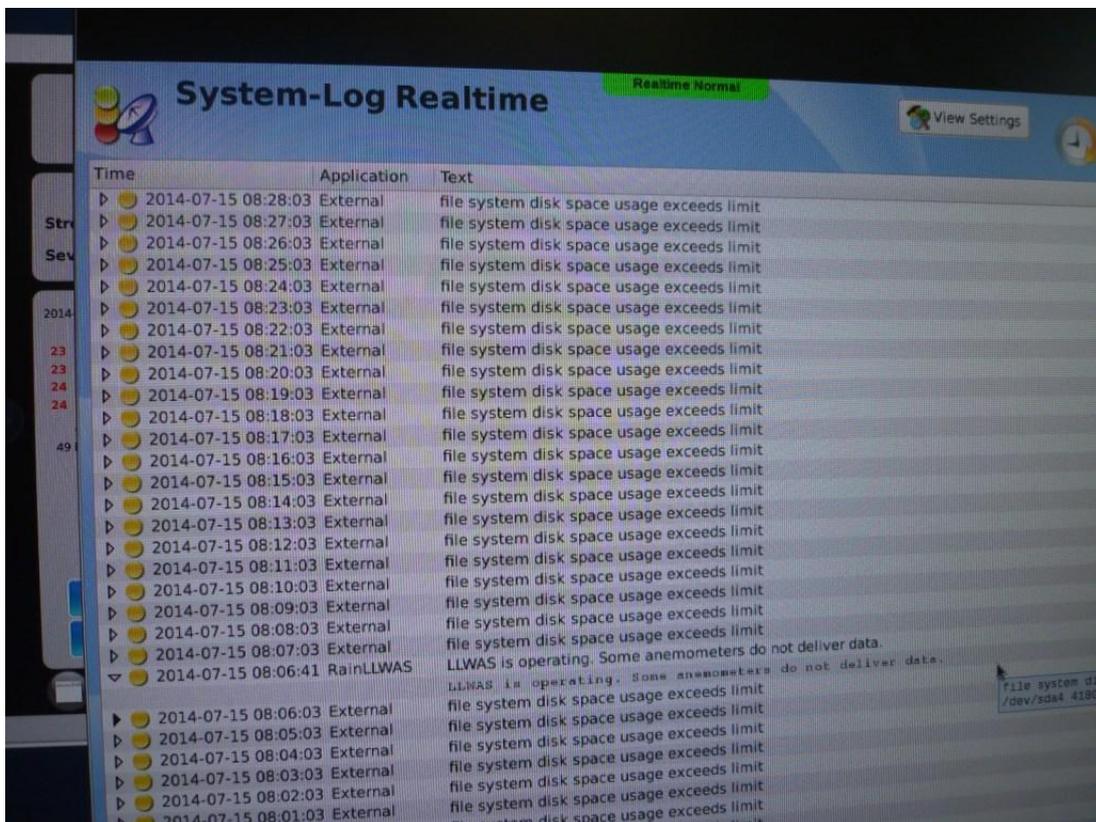
08:27:11

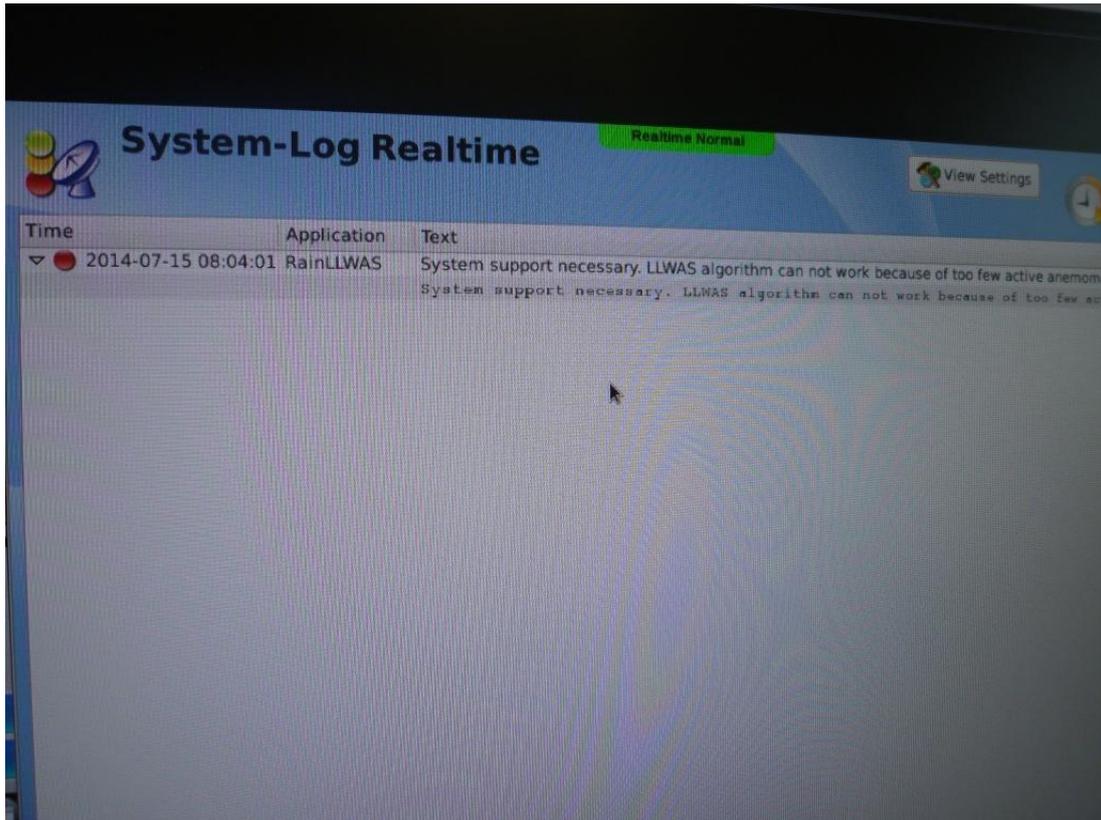
Clear

Step	Action	Expected Results	Check
3.4.41	<p>RainSCOUT log. Message - In case of a wind shear/ microburst alert is indicated to the controller within RainScoutATC client he has the possibility to acknowledge the alert.</p> <p>Verify by test to acknowledge a windshear/microburst alert at the workstation/client computer</p>	<p>A log-message will be generated that the alert is acknowledged.</p>	<p>OK. “alarm acknowledged” 將有記錄。</p>

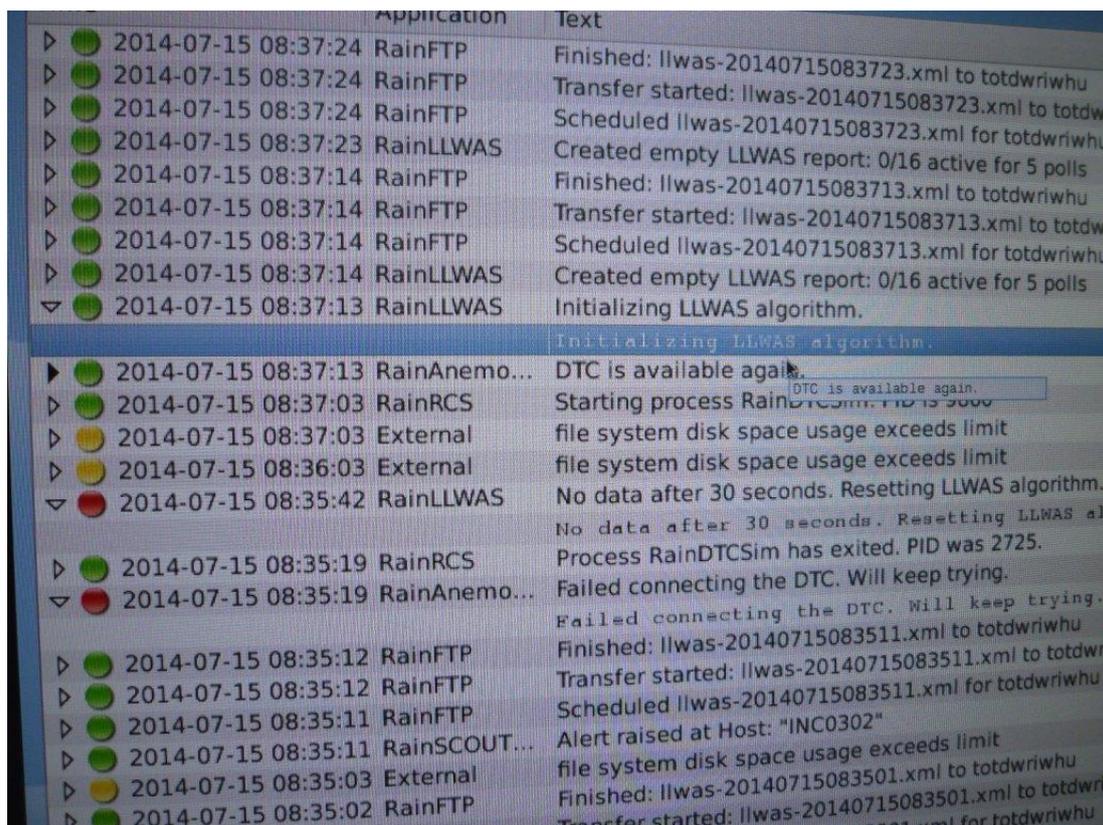


Step	Action	Expected Results	Check
3.4.42	<p>RainLLWAS log. Message shows all status information regarding the LLWAS algorithm.</p> <p>Verify by review:</p> <ul style="list-style-type: none"> - when the system is degraded but LLWAS is able to run, a warning shall be indicated “yellow sign” - when system support is needed, LLWAS is not able to run, an alert is generated “red sign” - the system has no data (LLWAS is off) an alert is generated “red sign” - the initialization is in process “yellow sign” 	The corresponding log-messages are generated.	OK. 系統狀態將依據不同告警程度記錄在「System-Log」中。並可篩選顯示的告警。

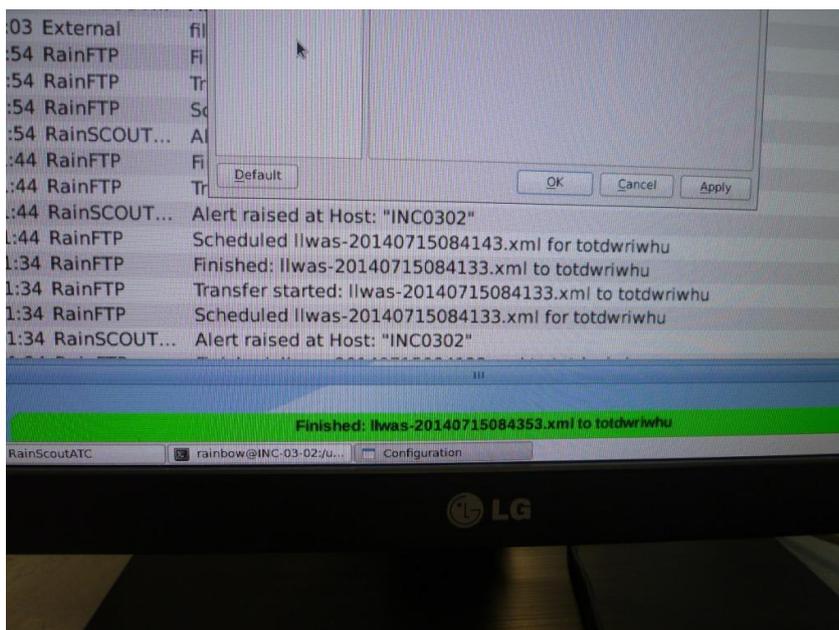
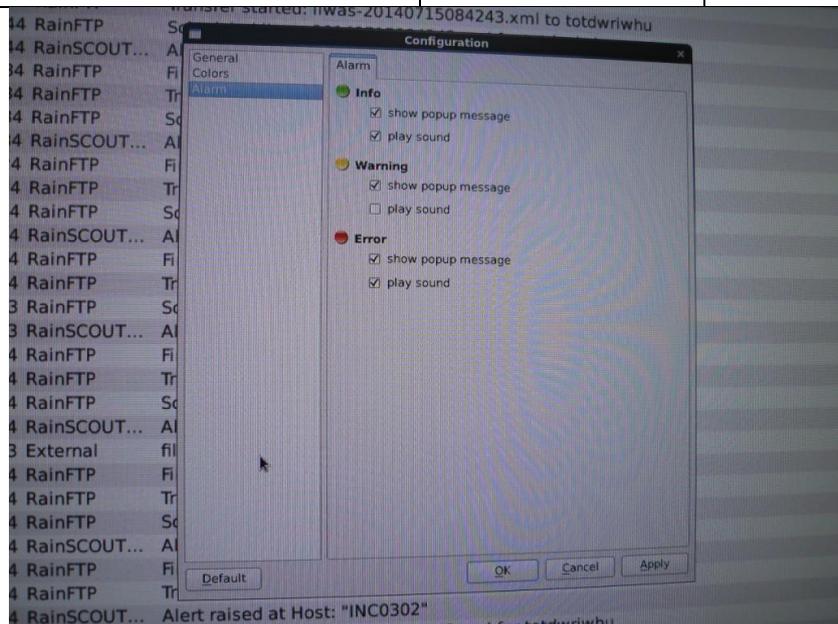




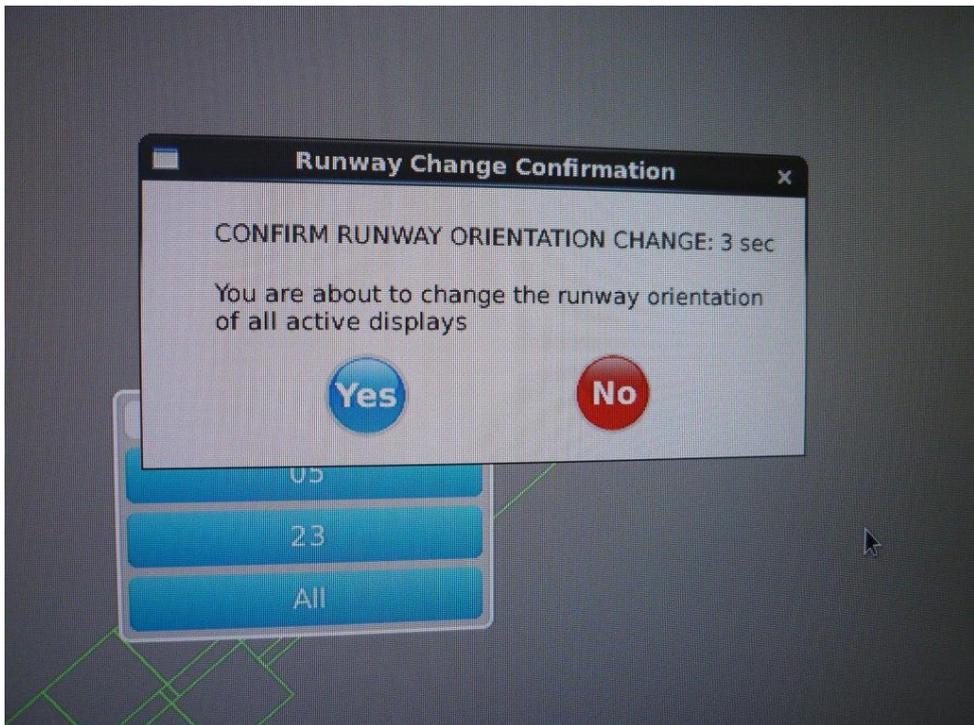
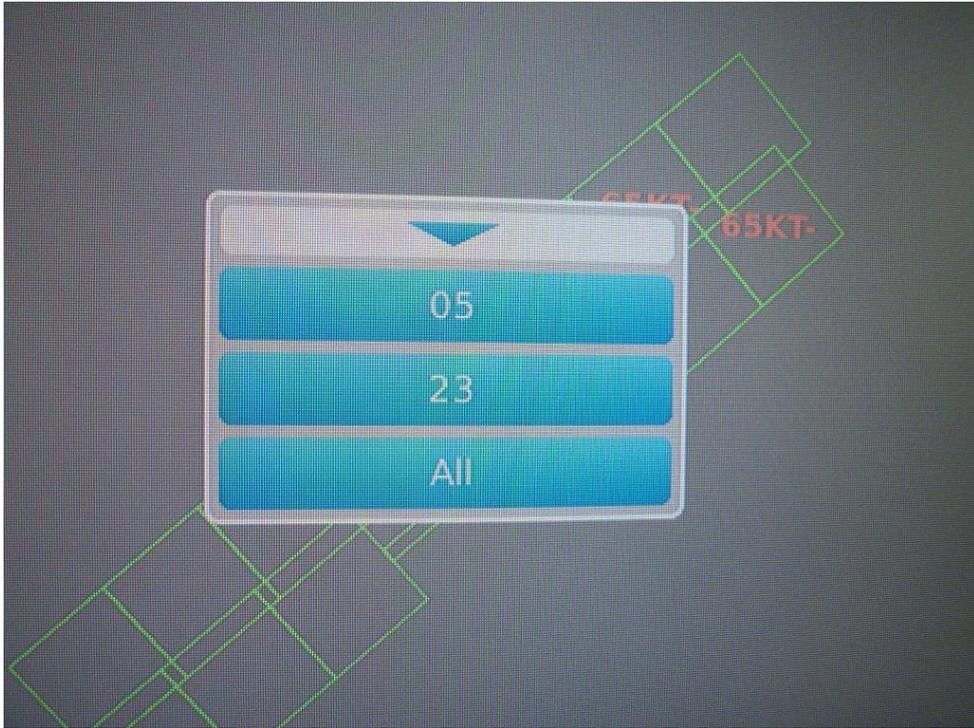
Step	Action	Expected Results	Check
3.4.43	Click on the green arrow on bottom on the left to verify: - the RainShear version number - on-line help - options	The function is working properly.	OK.
3.4.44	Verify by test to switch back to RainShear startup screen.	The start-up screen will be displayed.	OK.
3.4.45	Verify by review that the out of service interruption time, and communication failure status in system is logged.	The corresponding message is logged.	OK. 系統通訊失敗告警可正確顯示。



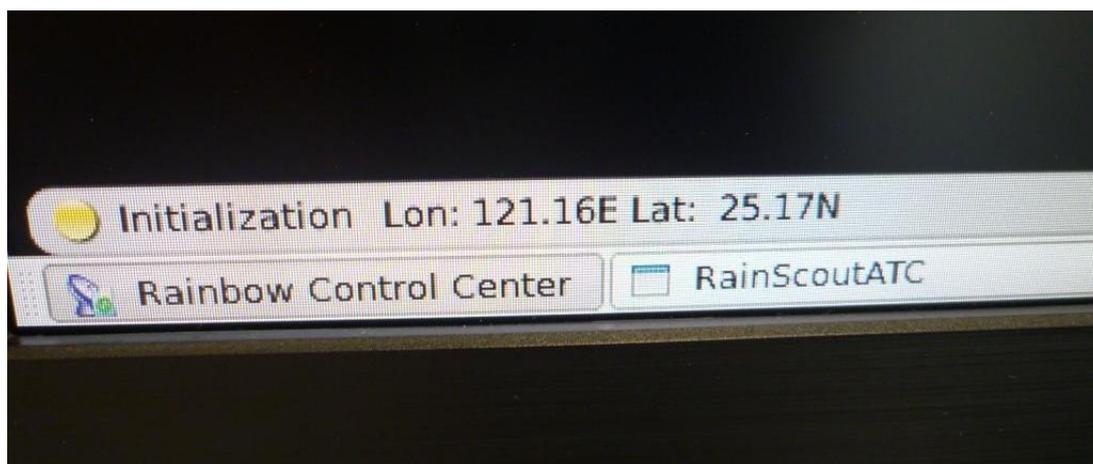
Step	Action	Expected Results	Check
3.4.46	Verify by review that self-diagnosis capability is available. When a malfunction of system or sensor or no signal, system must show a screen alarm and audible alarm. (The alert sound can be switched ON/OFF). The types of malfunction etc., shall be displayed and recorded in the servers		OK. 告警可以選擇以“Pop-up”或“聲音”方式呈現。

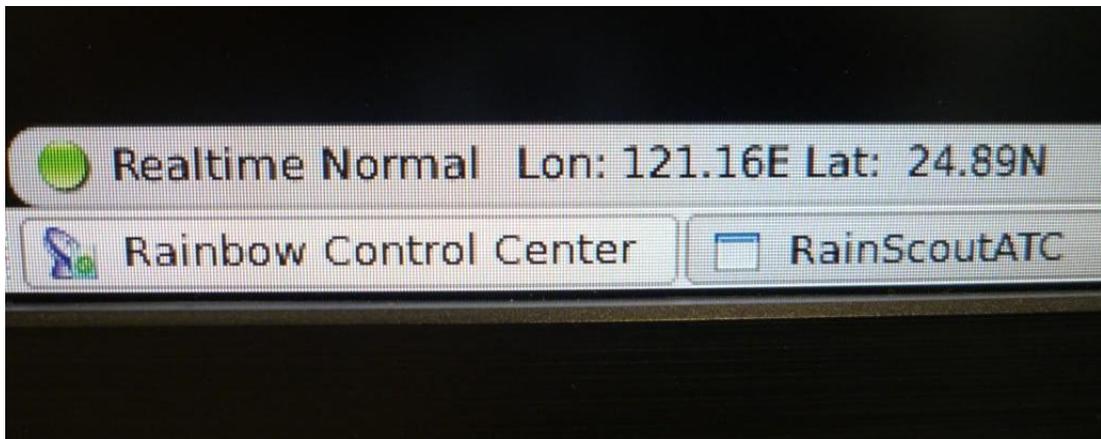
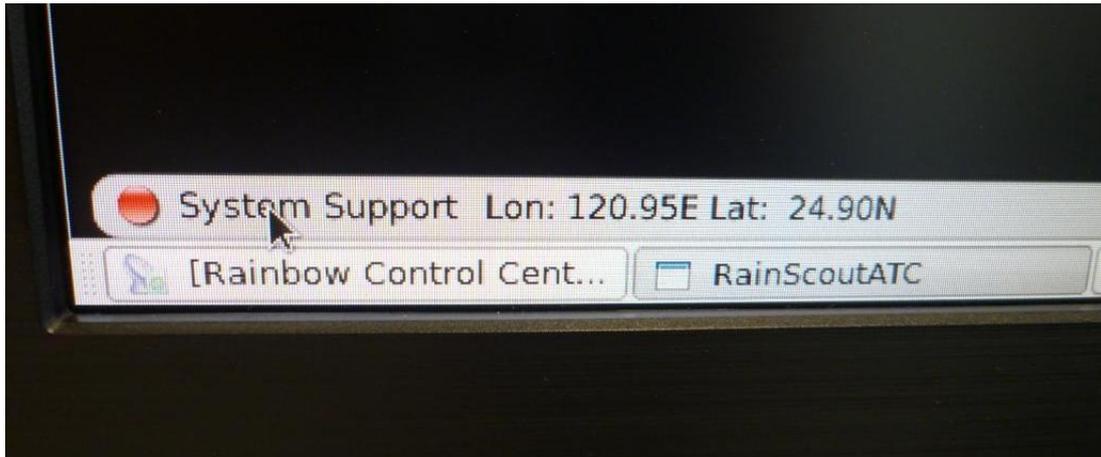


Step	Action	Expected Results	Check
3.4.47	Starting RainScoutATC using the Icon	RainScoutATC is open.	OK.
3.4.48	Verify by test that RWY mode is selectable.	Application allows to switch between RWY modes.	OK. 可選擇05方向或是23方向。

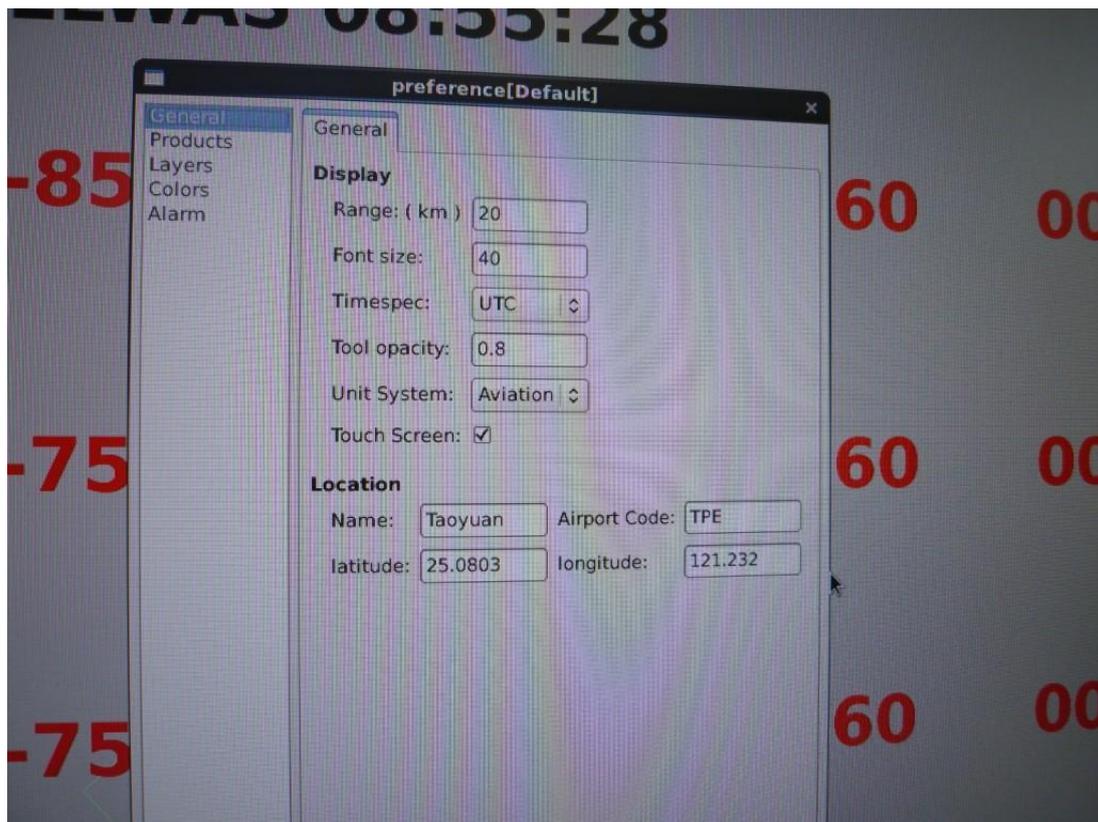


Step	Action	Expected Results	Check
3.4.49	Check the LLWAS System status which will be indicated in RainShear: Real time normal (green) Real time degraded (yellow) System Support (red) Initialization (yellow) Off (red)	This status should indicate when all anemometers 16 deliver wind data. Some anemometers 15-14 break down but LLWAS still operating. Too few anemometers out of order 13 - 0 the LLWAS is not able to operate. The LLWAS will be initialized (e.g. after restart) No Anemometer and also no RS status for more than n seconds (n is configurable)	OK. 依系統狀態顯示不同顏色提醒。

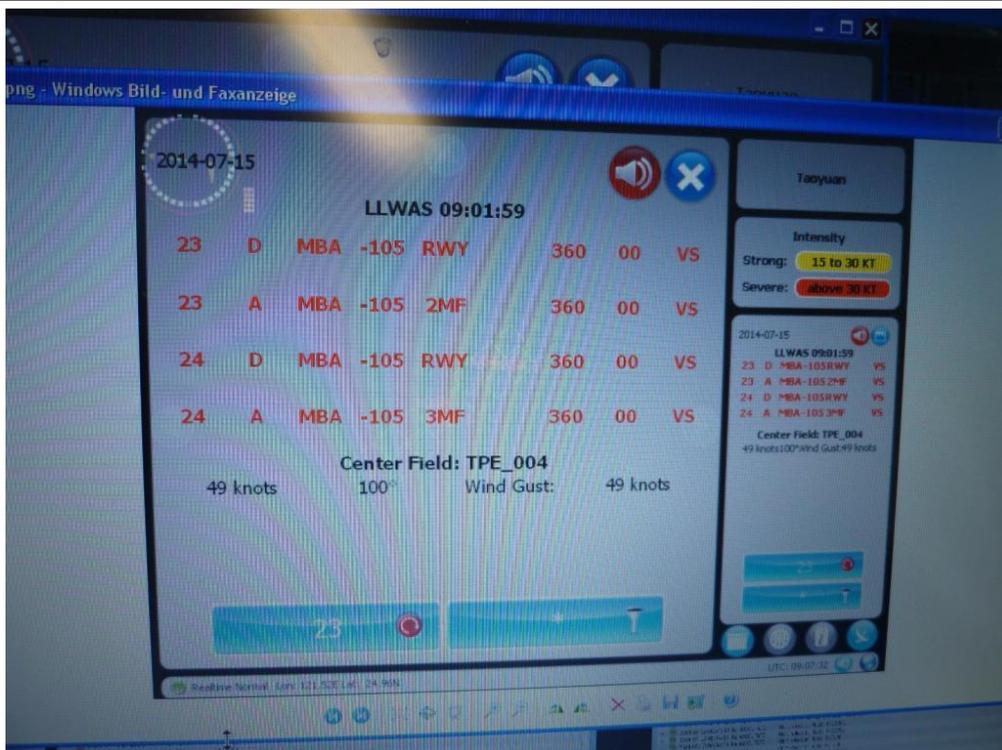




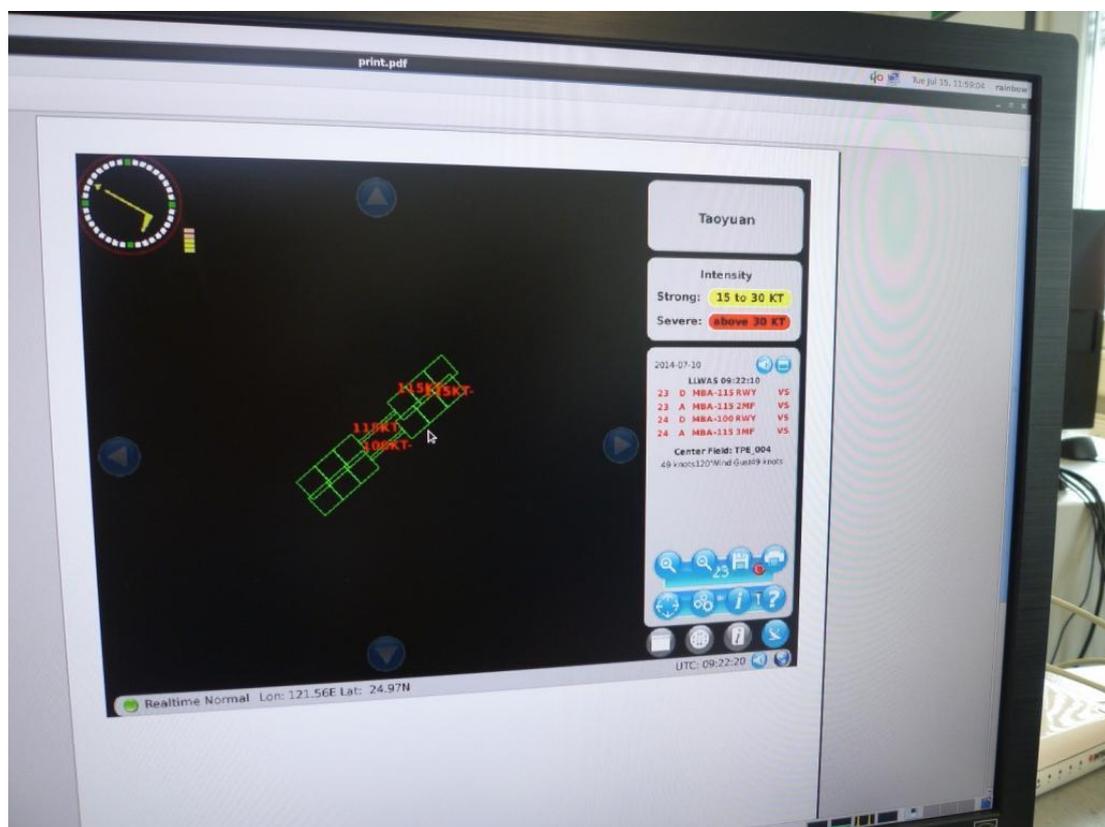
Step	Action	Expected Results	Check
3.4.50	Verify by review that data are available and fonts are readable on display.	The design corresponding the user needs.	OK. 字形及其他相關設定可於次畫面設定。
3.4.53	Verify by test that the alert can be acknowledged	The alert sound is muted.	OK.
3.5.54	Click on the setup button to verify the setting function: - version number - on-line help - font size setting - print function - save function - zoom function	The setting functions working reliable.	OK. 可列印輸出為PDF檔，或儲存為PNG圖檔。



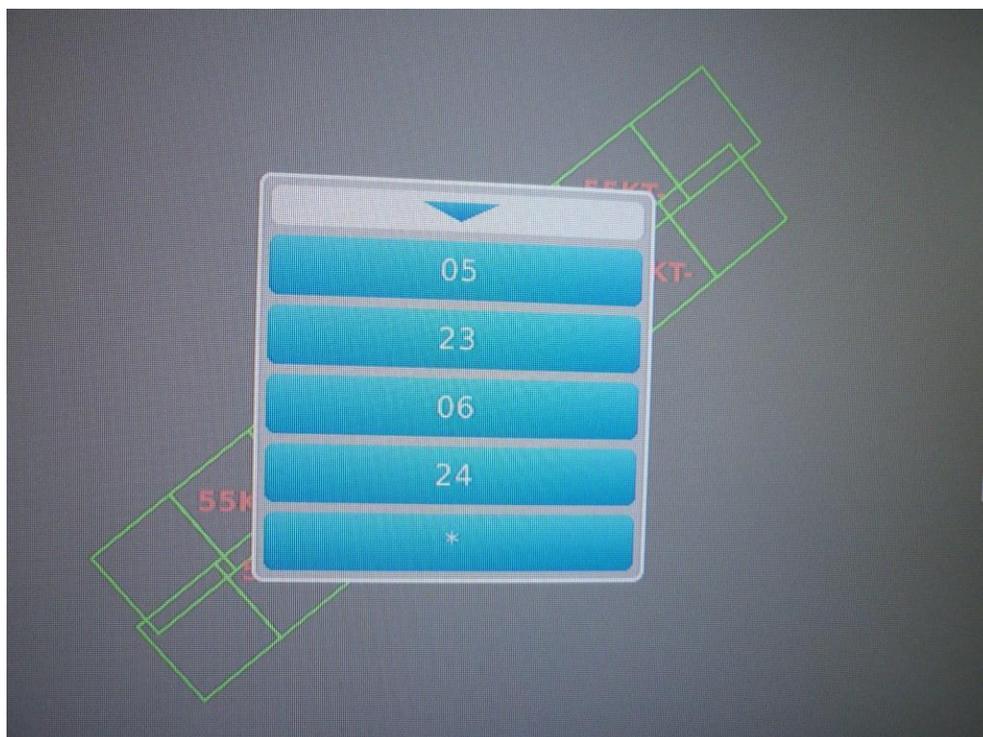
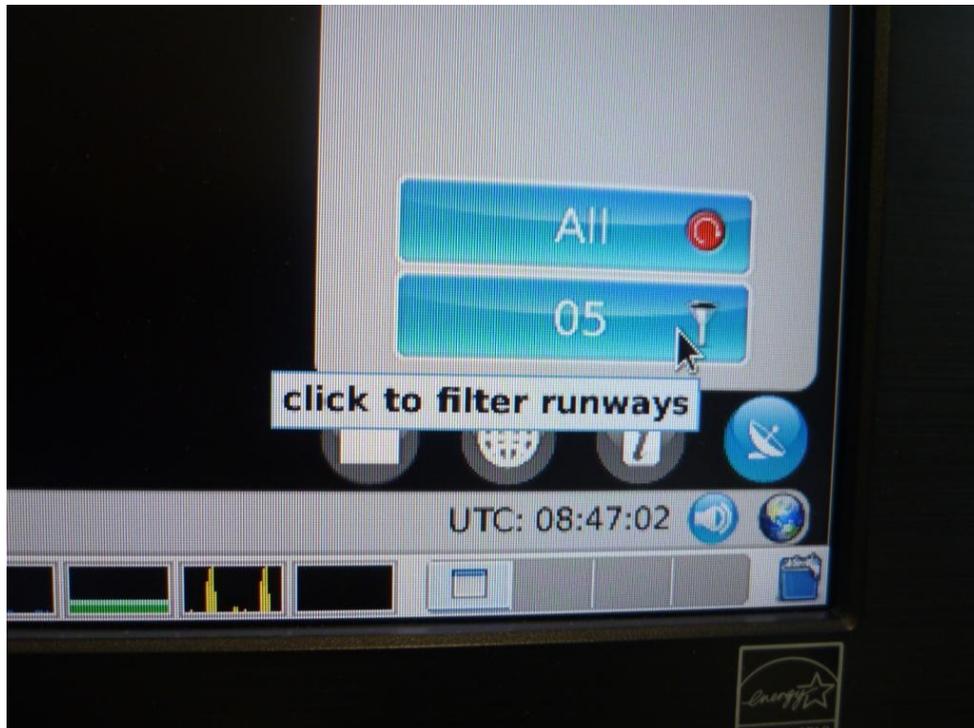
Step	Action	Expected Results	Check
3.4.51	Verify by review that the LLWAS CF wind data and alternates are available.	CF winds are available and alternate winds are provided if the primary is out of scan.	OK. 中場之風速、風向及陣風可被顯示。
3.4.56	Click to the button to switch to the AAD display showing the alerts on textual basis.	The Ribbon display is opened.	OK. AAD可選擇哪些跑道方向的告警被顯示。
3.4.57	Verify by review that the LLWAS RWY threshold wind data are available: - RwyA (arrival) - RwyD (departure) - etc. for each runway	RWY threshold winds are available and alternate winds are provided if the primary is out of scan.	OK.
3.4.58	Verify by review that an alert is indicated when a WSA or MBA is detected containing the information: - RWY Departure/Arrival - Location - WSA or MBA	The alert information are displayed.	MBA(微爆氣流告警) OK. WSA(風切告警)於工廠測試時未建模擬資料,故需於功能測試時再次驗證。



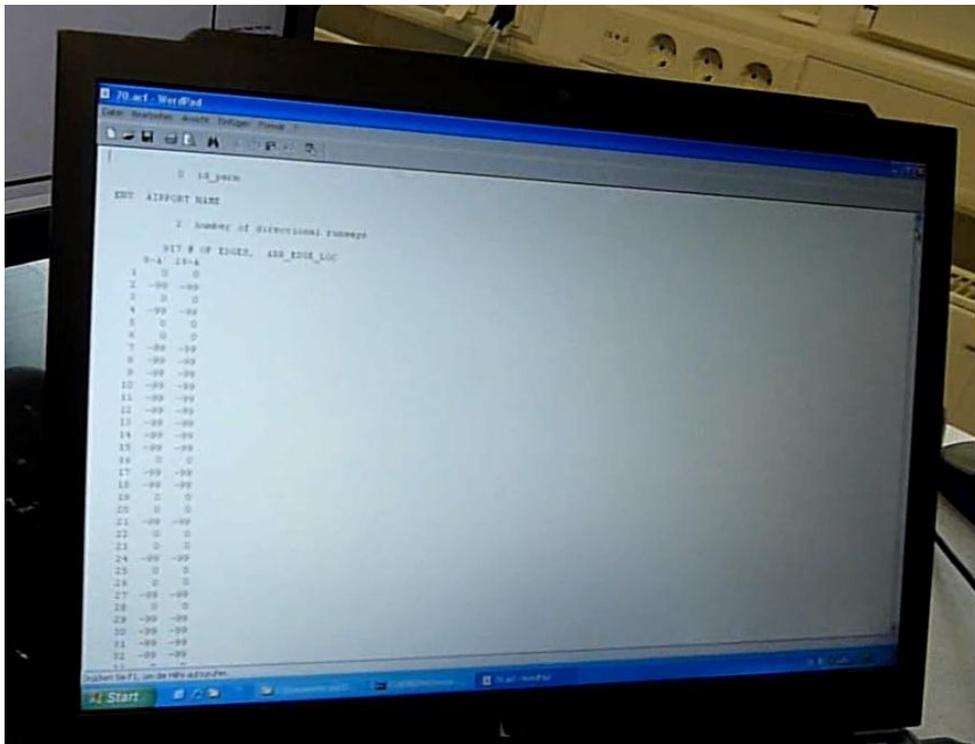
Step	Action	Expected Results	Check
3.4.52	<p>Verify by review the graphical mode functionalities of the RainscoutATC display:</p> <ul style="list-style-type: none"> - specific data messages show the following conditions in the correct format WINDSHEAR (WSA) MICROBURST (MBA) - RWY incl. 3 NM are Displayed - In case of WSA and MBA the location and intensity is displayed - an alarm message is indicated when a WSA or MBA is detected - an alert sound when a WSA or MBA is detected 	All example data formats are correctly displayed on the ATC displays	<p>MBA(微爆氣流告警) OK.</p> <p>WSA(風切告警)於工廠測試時未建模擬資料，故需於功能測試時再次驗證。</p>



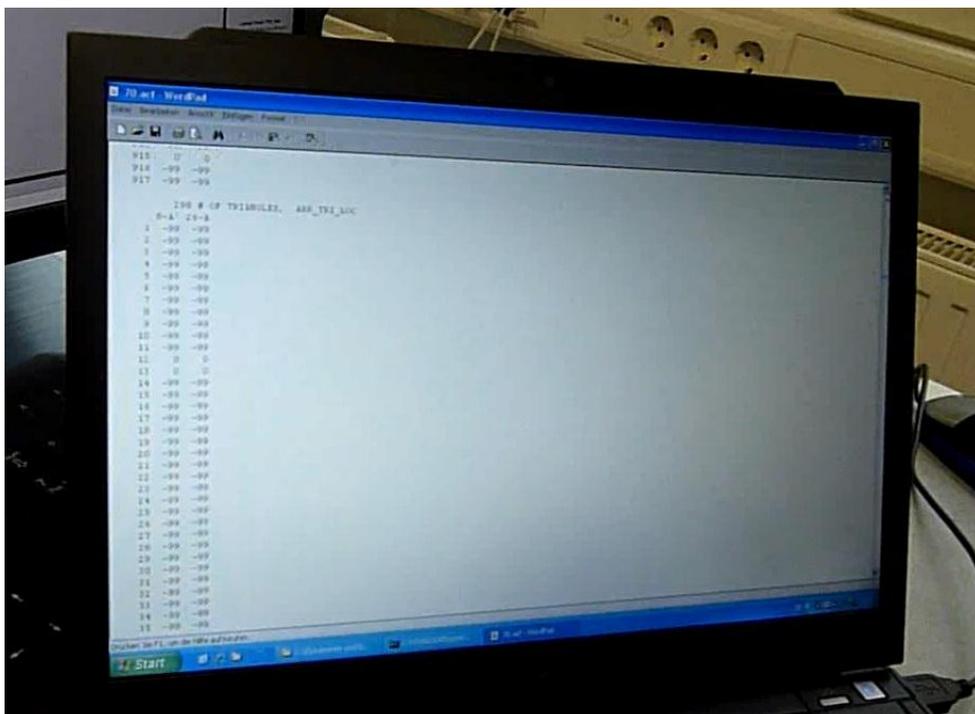
Step	Action	Expected Results	Check
3.4.55	Verify by test that the operator is able to select which runway information shall be displayed and the rest are not be displayed.	The specific RWY will be displayed.	OK. 可選擇哪些跑道方向的告警被顯示。



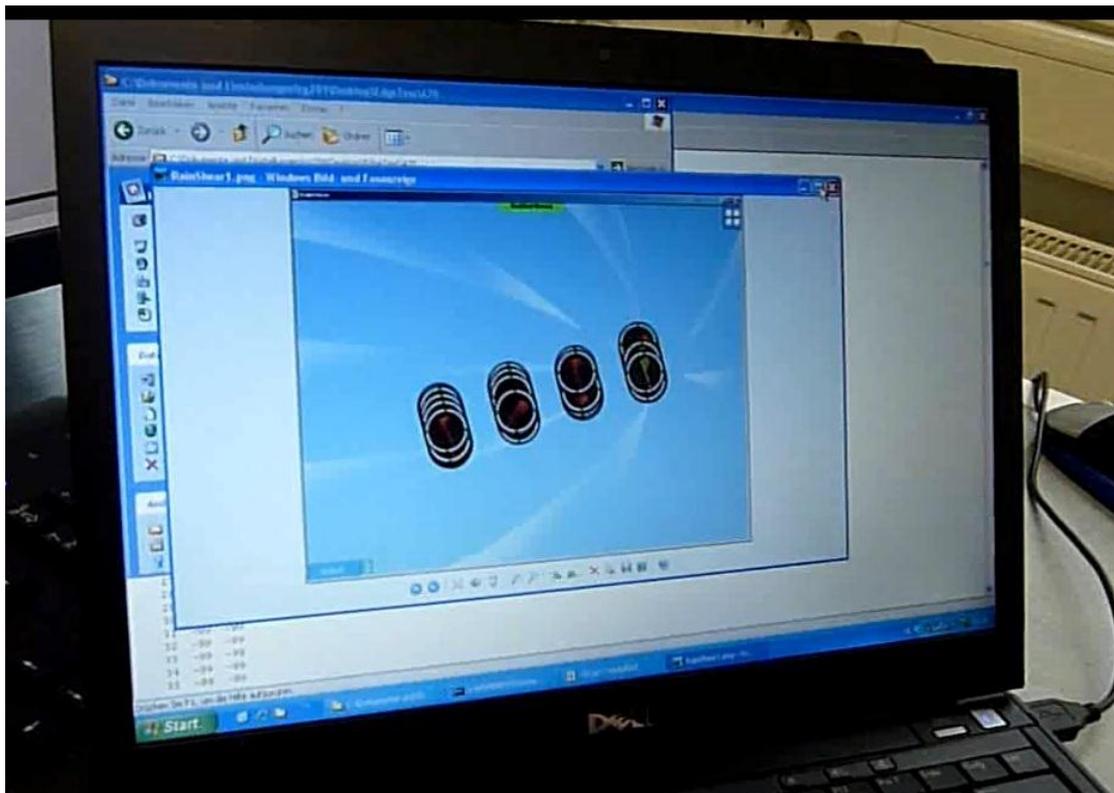
Step	Action	Expected Results	Check
3.4.59	Verify by review that algorithm has the capability to process 200 EDGES and 250 TRIANGLES.	The Req. is fulfilled	OK. 可模擬執行917 Edges、296 Triangles。



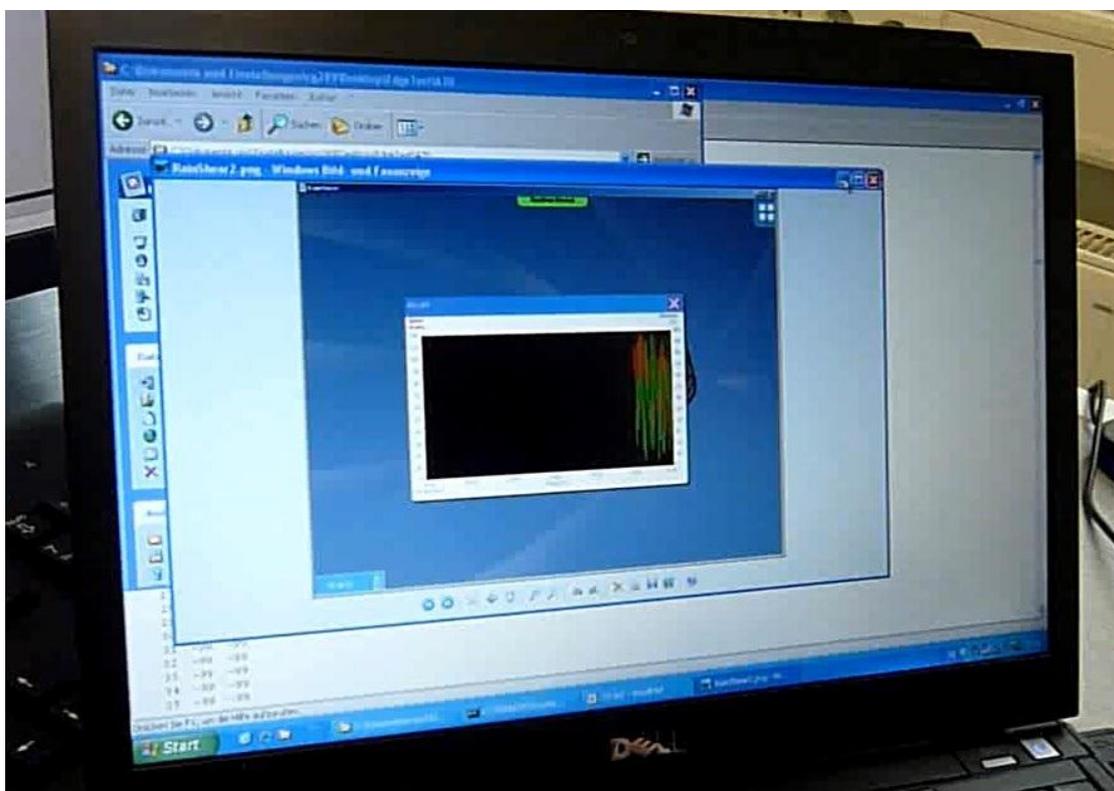
模擬 917 Edges



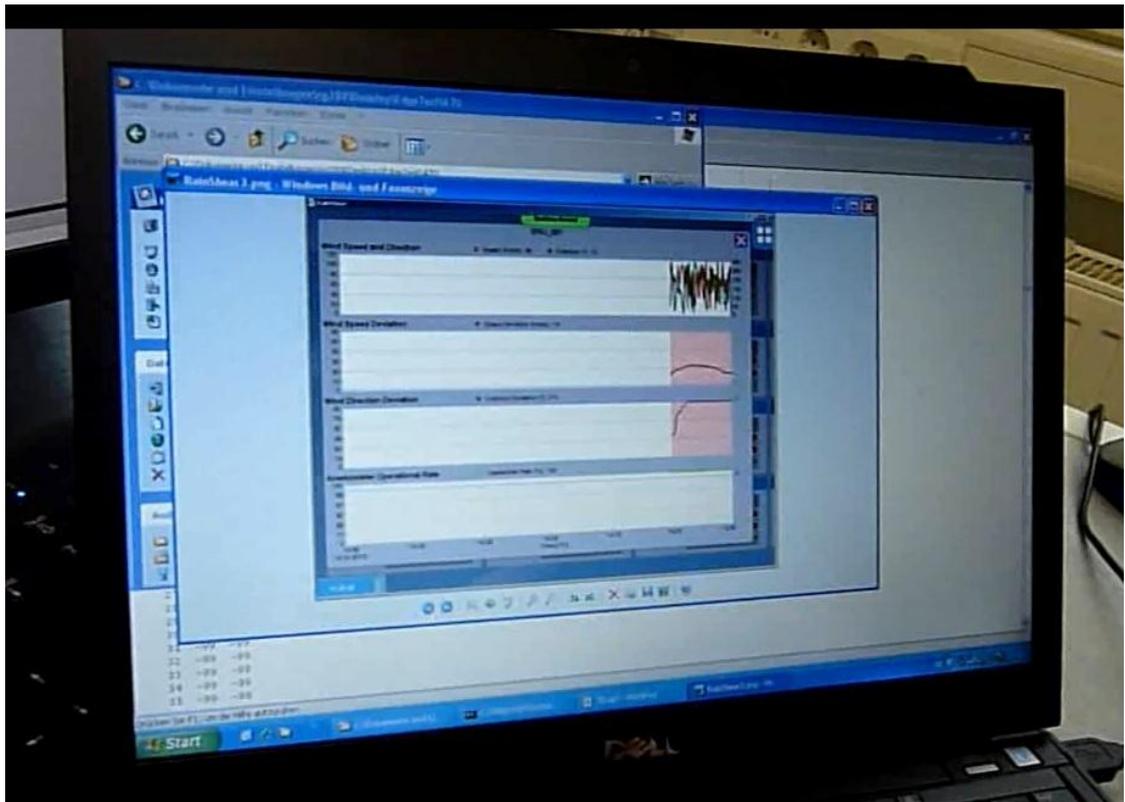
模擬 296 Triangles



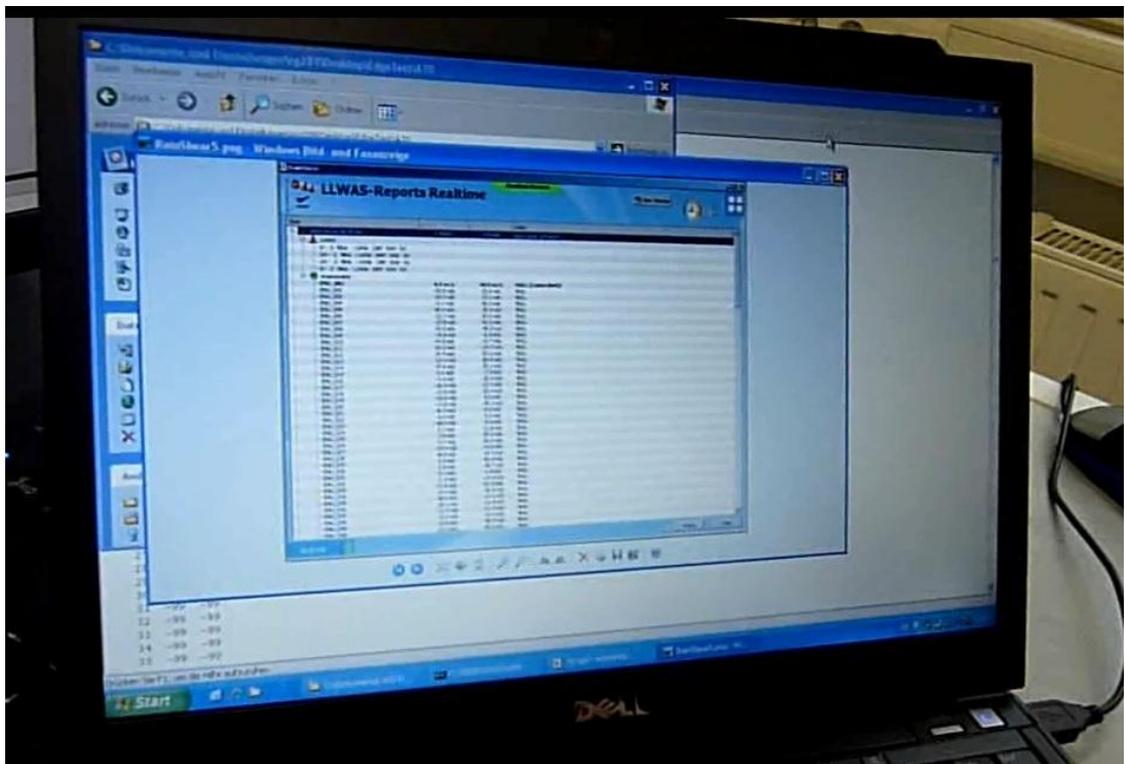
相對應的測風塔



模擬各測風塔的風速風向處理資料

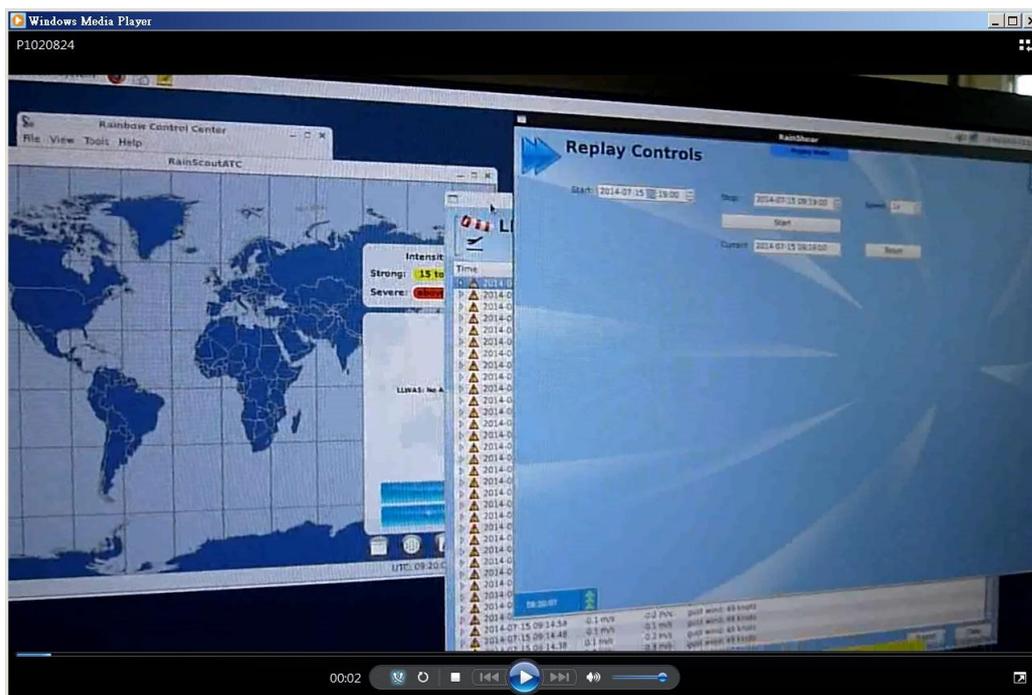
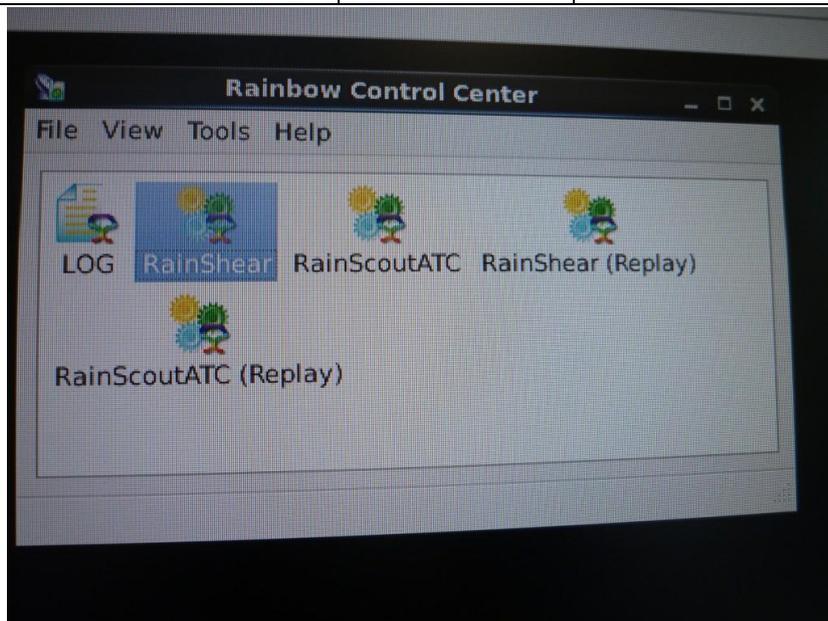


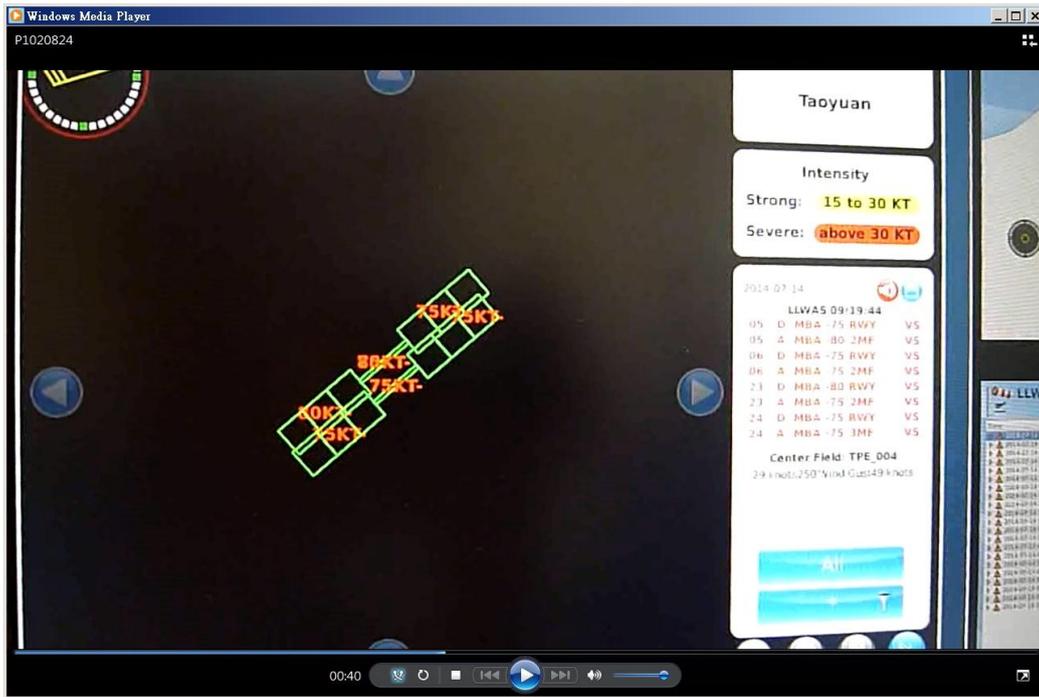
模擬測風塔的風速風向資料統計



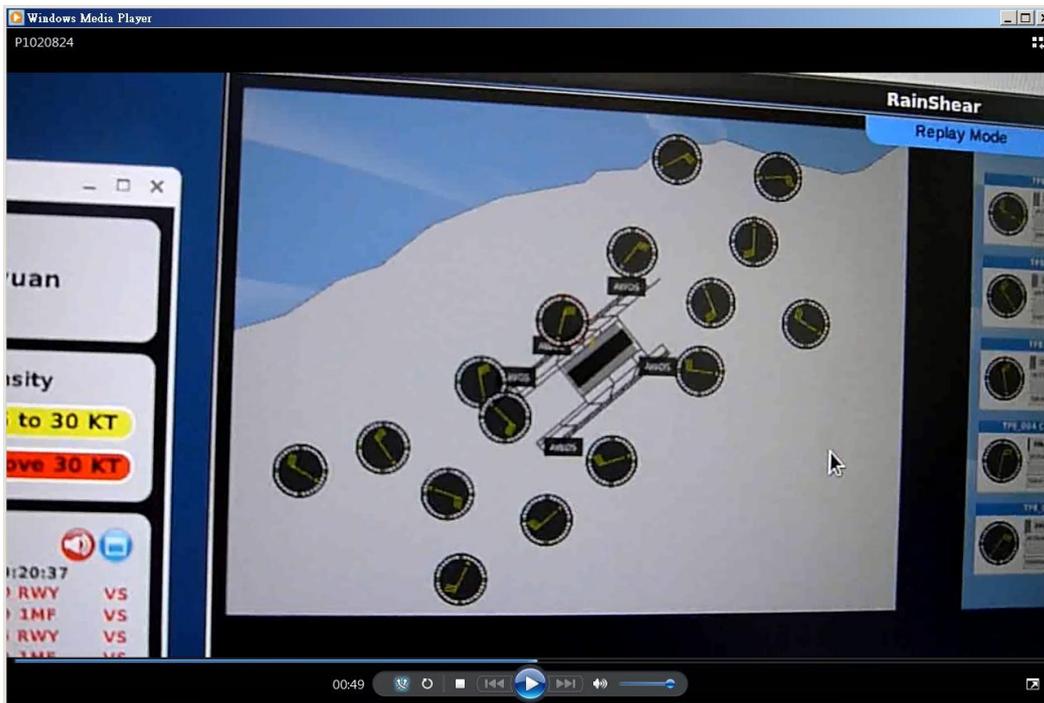
模擬LLWAS-Report記錄各測風塔資訊

Step	Action	Expected Results	Check
3.4.60	Verify by testing the wind shear events rebuilt and replay functionality at each available workstation showing each wind woeer warming status, alarm area, wind field analysis and AAD, GAD alarm display.	The Replay function is working properly.	OK. 開啟 ” Rainshear(Replay)” ” RainScoutATC(Replay)” 應用程式後，輸入重放的時間範圍後，GAD、各測風塔資料及系統告警均可一一重建。





GAD告警重建畫面



“Wind Situation Display” 告警重建畫面

Step	Action	Expected Results	Check
4.1	Verify that the runway direction, latitude, and longitude are as specified.	Examine settings and acf.txt values; compare with the approved list of airport latitude longitude specifications*	將請原廠更正跑道名稱為「05R」、「23L」、「05L」、「23R」。

```

4 # of RUNWAYS
16 # OF STATIONS
84 # OF TRIANGLES

15 PERSIS_QUE_LENGTH
15 QUEUE_LENGTH

RWY, RUNWAY_LAT(init, final), RUNWAY_LON(init, final), RUNWAY_X(init, final), RUNWAY
05A 25 5 40.19 25 4 22.42 -121 14 36.39 -121 12 57.55 7.019 4.091 3.6
23A 25 4 22.42 25 5 40.19 -121 12 57.55 -121 14 36.39 4.091 7.019 1.4
06A 25 4 52.33 25 3 41.15 -121 14 57.73 -121 13 27.29 7.511 4.832 2.0
24A 25 3 41.15 25 4 52.33 -121 13 27.29 -121 14 57.73 4.832 7.511 8.8

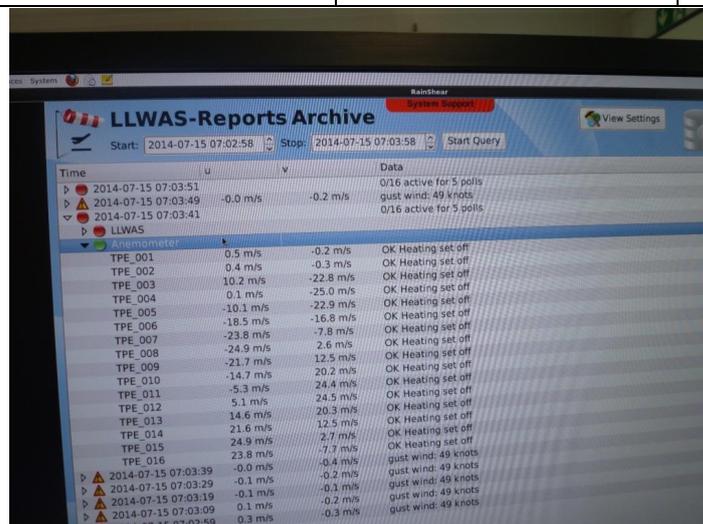
-99 RWY_LOC_FLAG

16 # of STATIONS, RWY_STAT_LOC
05A 23A 06A 24A
1 3 -99 -99 -99
2 2 -99 -99 -99
3 1 0 -99 -99
4 0 0 -99 -99
5 0 1 -99 -99
6 -99 2 -99 -99
7 -99 2 -99 3
8 2 -99 2 -99
9 1 0 1 0
10 0 1 0 1
11 -99 2 -99 2
12 -99 -99 2 -99
13 -99 -99 1 0
14 -99 -99 0 0

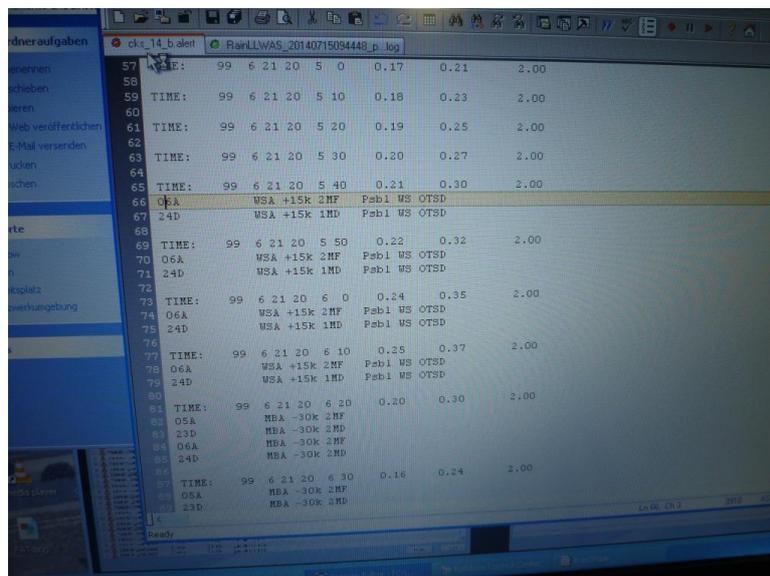
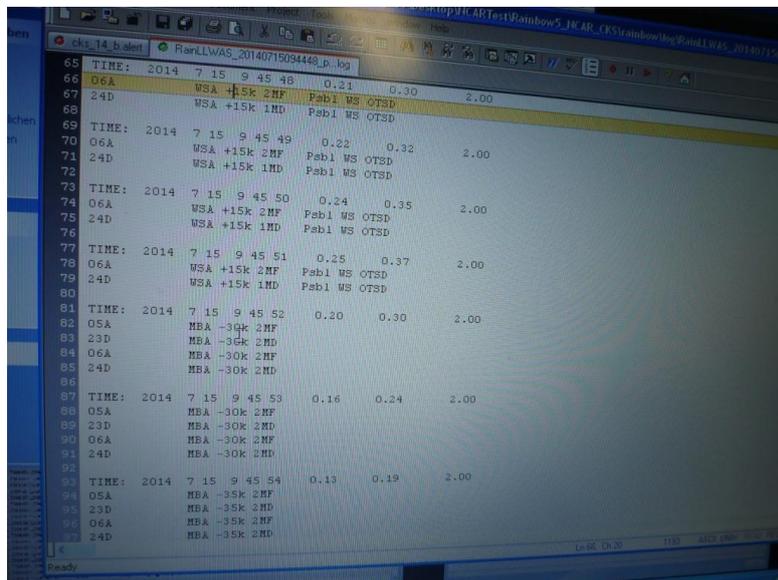
```

Step	Action	Expected Results	Check
4.2	Verify that the latitude and longitude of wind sensor sites are as specified.	Examine settings and acf.txt values; compare with the approved list of airport latitude longitude specifications.	OK. 按總臺所給測風塔經緯度位置設置。
4.3	Verify that Centerfield sensor and alternates are correctly specified.	Examine the RainLLWAS.ini file; compare with the approved list of threshold sensors and alternates.	OK. 按總臺所給中場經緯度位置設置。
4.4	Verify that the RWY threshold sensors and alternates are correctly specified.	Examine the RainLLWAS.ini file; compare with the approved list of threshold sensors and alternates	OK.

Step	Action	Expected Results	Check
5.1	Verify that history data are stored and can be opened as specified.	History files have been saved and can be opened and displayed.	OK. 歷史資料存放於”Archive”資料庫中。
5.2	Verify the content of the history files.	- Time and Date - Wind Data - WS Alerts - MB Alerts - System Status	OK. 相關資料均有儲存於資料庫中。
5.3	Verify the export of the history files	History files can be exported in XML format	OK.
5.4	Verify by test the possibility to open and display archived events within RainShear. The following information shall be contained: - ability to access to the archived data of files every time - ability to perationally filter the archived data as form of alerts - ability to display the status of the LLWAS system during archive request - archived data can be downloaded to a removable media.	All functions are working reliable.	OK. 資料庫儲存資料可被正常讀取、篩選以及儲存為檔案攜出。



Step	Action	Expected Results	Check
6	<p>Verify the operation of LLWAS algorithm by comparison with NCAR (The National Center for Atmospheric Research) test data.</p> <p>Testing is done by using input files furnished by NCAR (including configuration files) and comparing the resulting alerts pr with alerts produced by the <i>Selex ES GmbH</i> LLWAS implementation.</p>	The comparing result is identical.	<p>OK.</p> <p>將”桃園機場 WSA+MBA”告警發生的天氣條件輸入 SELEX公司的系統與NCAR演算法產生的告警檔 (cks_14_b.alert) 吻合。</p>



(四)、測試結果

本次工廠測試下列測試項目需於功能測試時再次確認：

1. 伺服器及工作站之硬體規格。
2. 伺服器 MS1 與 MS2 之「Hot/Hot」或「Hot/Stanby」模式。
3. WSA 告警顯示。
4. 跑道名稱更正。

除上述待確認項目外，其餘測試皆已符合技術規範說明書所述需求。

五、心得

眼見即所得，是最適合形容總臺原有 LLWAS 系統的一句話；將所有的資訊顯示在同一個顯示畫面裡，方便使用者獲取所需。GAD(Graphic Alarm Display,圖形化告警顯示)，以三角形標示出風切發生的區域；AAD(Alphanumeric Alarm Display,文數字告警顯示)，顯示風切告警的位置，是在跑道的頭、中或是後，並且顯示出風切數值的大小。但換個角度來看，由於終端使用者為氣象人員與管制人員，所需資訊大大不同，過多的資訊造成了不必要的困擾，所以衍生出子程式來獲得較為簡化的資訊。

即將換裝的 LLWAS 系統為一個整合式的系統，目前亞洲有新加坡及韓國使用，系統將目前分散的功能完整整合，但又可以適度的分開。另外，考量到管制人員使用上的便利性，將警示依跑道畫分為數個區域，當有風切告警時，可以明確得知風切警報發生的位置及數值大小，將可更有效的增進飛航安全。

六、建議

- 一、 傳統與現代，過去與未來，使用者介面有時會是系統轉換的阻礙，尤其是對一個使用十年的系統更甚之，是故良好的溝通與協調絕對是解決此一問題的良藥。在出發前往德國工廠測試前，由於行前無法對新系統有較為完整的了解，故心中存在許多的疑問，甚至害怕無法順利完成任務，但在經過與德國原廠溝通後，幾乎所有的問題都迎刃而解。所以在出發前，原廠代理商如能就工廠測試程序中可能會遇到的問題，先跟我方人員溝通，解決心中疑惑，應該會讓工廠測試更為順

利。

二、 改變，破壞了原有的運作規律，讓原本熟悉的系統變得陌生；改變，卻也是進步的動力，引入更有效率的系統來增進飛航安全。總臺現有的 LLWAS 系統已建置 13 年餘，這 13 年來，電腦硬體的進步以及軟體程式的開發已非同日而語。當然，改變是會帶來一些痛苦的，尤其對於肩負飛航安全第一線的氣象及航管作業同仁，不熟悉系統作業可能會提高風險。也希望能透過充分的溝通與完整的事前訓練，讓磨合期盡快的度過，以嶄新的 LLWAS 系統來提供桃園及松山機場更有效率、更安全的飛航服務。

七、附錄：工廠測試文件



**FAT Protocol for LLWAS Software
Procedures
at
TaoYuan Airport and Songshan Airport**

Within several sub-sections of the protocol all LLWAS-3 functionalities are verified and tested. The protocol shall be executed using TaoYuan airport design. The functionalities are the same for Taipei Airport.

Header

Issue Authority: Selex ES	
Prepared by: Nils Tatjes (System Engineer)	Date: 12.06.14
Prepared and Approved by: Dr. René Graßelt (Project Manager)	Date: 12.06.14

Revisions Record Sheet

This sheet is a record of revisions to this document.

Issue	Date	Revised Pages	Document Change Note (DCN)
1.0	12.06.14	All	Version 1.0
2.0	09.07.14	All	Version 2.0

List of Abbreviations

ICD	Interface Control Document
LLWAS	Low Level Wind Shear Alert System
RS	Remote Sensor
MS	Masterstation/ Server
MB	Microburst
WS	Wind Shear
DTC	Data Transport Collector

1. General Information

The Factory Acceptance Test (FAT) procedure described in the documents provided by Selex ES GmbH will be performed at Selex ES GmbH premise in Neuss/Germany.

Instructions to the FAT Test Team

The procedures described in this document provide observable confirmation of all LLWAS components and functionality which will be delivered and installed on-site by *Selex ES GmbH*. The tests are conducted by a mutually approved representative, who is trained in the FAT/SAT procedure by the *Selex ES GmbH*.

The test process and results are observed and verified by the procurement FAT/SAT test team. Each test item is described as to its objective, the test process, and the expected observable result. After a test procedure is conducted and there is a test team consensus that the observed result is satisfactory, that item is checked as successfully completed.

When all of the test items on a page are checked, each participating member of the test team and the participating *Selex ES GmbH* staff will initial the bottom of that page, indicating their concurrence with the approval of those test items.

When all test pages have been successfully completed, so indicated by the checked test items and the initials of the test team, the test team will sign the Signature Pages of this document, indicating the successful completion of the Factory Acceptance Test. The multiple signature pages will be distributed as required. The completed FAT documents and one signature page will be retained by *Selex ES GmbH*.

2. Verification of the IT system – Review of Design

Objectives

Factory Acceptance of the IT system verifies that all hardware components are present which are required to operate the LLWAS system. The acceptance doesn't include any infrastructure needed at the site.

Step	Action	Expected Results	Check
2.1	Hardware Check Rack System		
2.1.1	Verify by review that a 19" inch Rack for hosting the server computers is installed.	The Hardware Req. is fulfilled.	*
2.1.2	Verify by review that the Rack is equipped with: <ul style="list-style-type: none"> • 2 Servers • 1 UPS Power Supply • 1 Monitor, Keyboard, Mouse Unit • 1 KVM Switch • 1 Switch/Router 	The Hardware Req. is fulfilled.	*
2.1.3	Verify by review that both MS are equipped with: <ul style="list-style-type: none"> • 1 DVD-RW • 2 HDD ≥500GB • 2 GB Memory Command: free -m • 1 Redundant Hot Plug Power Supply • Ethernet Port 	The Hardware Req. is fulfilled.	*
2.1.5	Verify by review that both MS are equipped with an operating system: Linux Red Hat Command: lsb_release -a	The Req. is fulfilled	*
2.1.6	Verify by review that 2 HDD ≥500GB are available for spare part.	The Hardware Req. is fulfilled.	*
2.2	Hardware Check Workstation Computers		
2.2.1	Verify by review that 2 Workstations are available.	The Hardware Req. is fulfilled.	*
2.2.2	Verify by review that both Workstations are equipped with: <ul style="list-style-type: none"> • CPU ≥ 3GHz • HDD ≥ 500GB • RAM ≥ 512MB 	The Hardware Req. is fulfilled.	*

	<ul style="list-style-type: none"> • 1 DVD-RW • Monitor (≥19") • Keyboard/Mouse • Ethernet Port • All cables and connectors <p>Restart Workstation – Start Bios (Press Escape)</p>		
2.2.3	Verify by review that both Workstations are equipped with an operating system: Windows 7 – full licensed	The Req. is fulfilled.	*

*Only applicable when HW is available

3. Verification of the Server Design and Software

Objectives

Factory Acceptance Test of the software system shall demonstrate that implementation and functionality of all components needed to operate the LLWAS Phase 3 algorithm is correct.

A successful demonstration ensures a reliable wind shear, microburst detection system which is ready for installation on-site. The functionalities introduced during the FAT procedure are based on the input of test data and test environments.

3.1 General Server Setup

Step	Action	Expected Results	Check
3.1.1	Login into MS system using Login/Password provided by Selex. - Test shall be executed on both MS	The user is able to login into both MS.	*
3.1.2	Verify by review that a structural program technique is used. - Test shall be executed on both MS	The user identified a clear directory and file structure.	✓
3.1.3	Verify by review software maintaining/reporting: Check if S/W is made in plain English. The Operating System is Linux Red	The user identified: The software language is English.	

	Hat 6.x Check if S/W is operated and the data processes on Linux Red Hat system.	The MS operates with Red Hat.	✓
3.1.4	Verify by testing to switch between both MS.	A key combination allows to switch between both MS.	*
3.1.5	Check the redundant server system mode "hot hot". Simulate a breakdown of one MS. Command: <code>/usr/local/Rainbow5/rainbow/bin/rainrcs.sh stop</code> Verify by review that both MS receiving row data simultaneously. <i>Change from HOT-HOT to Hot-stand by Mode</i>	The second system proceeds with the work. An alert should be generated. Data are received simultaneously.	✓
3.1.6	While switching between Primary (MS1) and Secondary servers (MS2), the screen alert and voice alarm shall be presented. The switching function between servers could be implemented automatically.	The function is confirmed.	*
3.1.7	Check the UPS function: Unplug the server system from electricity. Operating only with UPS power to simulate a longer blackout and to provoke an emptying of the battery.	The UPS provides the MS with electricity. The LLWAS system is running without any disruptions. Both servers shutting down automatically when UPS battery reaches a critical level.	*
3.1.8	Verify by review that CPU operational load is less than 50%, usage of memory is lower than 50% and HD space occupied right after the initial installation is lower than 50% of the total capacity.	The Req. is fulfilled <i>Must be confirmed during SAT</i>	* ✓ FAT 01

*Only applicable when HW is available

3.2 General Workstation Setup

Step	Action	Expected Results	Check
3.2.1	Verify by review that Windows 7 64Bit version is installed	The Req. is fulfilled	*
3.2.2	Verify by testing the LLWAS client software is installed. Open "RainShear" Open "RainScoutATC"	The user is able to open both programs.	✓
3.2.3	Workstation Date and Time setup: Check if time and date on client computers are configurable	The user is able to setup the time.	*
3.2.4	Maintenance workstation should be opened in average of 1 second, in maximum of 3 seconds after the operator issue a request command, and should perform reaction with system at an average of 5 seconds, in maximum of 15 seconds.	The Req. is fulfilled	✓
3.2.5	When the maintenance workstation can't provide the screen warning or alert message via the monitor, the system shall provide audible sound or other feasible way to alert maintainer for the warning or alert message.	The Req. is fulfilled	✓
3.2.6	The executed command on Maintenance workstation (such as reboot or reset action) should not make any adverse effects in the running LLWAS system.	The Req. is fulfilled	*

*Not Applicable - Maintenance Workstation not available during FAT

3.3 Software, Interface Verification Masterstation

Step	Action	Expected Results	Check
3.3.1.	Verify by testing that operators are in the situation to set time on both systems. The time shall be displayed in line with network time. The ShearScout/ LLWAS uses these applicable hours in storing files, maintaining and operating every other function.	Examine time setting function on both systems. Storing a file and examine the file name. The file name is stored using time provided by the servers (GPS time).	✓
3.3.2	Verify that the MS is able to receive wind data from each RS, checks the contents of data and record the time. Verify that all the MS data will be upgraded with current wind data.	Examine the data received from DTC.	*
3.3.3	Verify that MS is able to calculate the Network Mean	Examine the Network Mean Values.	✓

*Only applicable when HW is available

3.4 Software Verification on Client/ Workstation

Step	Action	Expected Results	Check
3.4.1	Login into client system	The user is logged in.	*
3.4.2	Starting RainShear using the Icon	RainShear is open.	
3.4.3	Check the LLWAS System status which will be indicated in RainShear:		Check - fill data gaps 30 sec
	Real time normal (green)	This status should indicate when all anemometers 16 deliver wind data.	
	Real time degraded (yellow)	Some anemometers 15 - 16 breaks down but LLWAS still operating.	✓
	System Support (red)	To few anemometers out of order 12 - 0 the LLWAS is not able to operate	
	Initialization (yellow)	The LLWAS will be initialized (e.g. after restart)	
	Off (red)	No Anemometer and also no RS status for more than n seconds (n is configurable)	
3.4.4	Open the Wind-Situation Display (RWY underlay)	Wind-Situation Display window is open.	
3.4.5	Verify by review that sensor information is shown on the Wind-Situation Display I	Wind-Situation Display indicates wind sensor information (wind speed, wind direction or in case of break down the current status) of each anemometer.	✓
3.4.6	Verify by review that the wind speed and directions are updated by each anemometer and displayed on the Wind-Situation Display	The wind parameters are updated every 10 seconds.	✓

3.4.7	Verify by review that in case of sensor breakdown the code "error" is displayed.	The "error" message is indicated of failed anemometer/s.	✓
3.4.8	Verify by review that the centerfield sensor is indicated.	The centerfield sensor is displayed.	✓
3.4.9	Verify by test and click on any anemometer to display the temporal evolution of wind direction and wind velocity	An extra screen is displayed containing overview of wind direction and wind velocity.	✓
3.4.10	Verify by review that the gust wind is displayed	Wind-Situation Display displays gust wind. <i>maybe bigger</i>	<i>(signature)</i>
3.4.11	Verify by review that the system is be able to access the wind speed and wind direction data in Buyer's existing AWOS system (for Taoyan airport, it shall include data in the middle of runway) at both ends of runway, and display this numerical value on AAD and GAD.	The AWOS information are displayed.	✓
3.4.12	Verify by review that users are able to read the AWOS information on the screen.	The AWOS information are displayed.	✓
3.4.13	All displayed windows for wind shear, wind data and AWOS information are displayed inside the same screen to easy operators operating.	The Req. is fulfilled.	✓
3.4.14	Verify by review that the wind direction at the middle of airport is indicated by three digits from 001 to 360; the wind speed is indicated by two digits from 03 to 95 Knots, less than 3 Knots is indicated by CALM; the gust is indicated by two digits. If the maximum	The Req. is fulfilled.	

	wind speed is greater than the previous of two minutes average, system should display it on screen.		  <i>check → 2 Minutes or 10 Minutes</i>
3.4.15	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	
3.4.16	Open the Maintenance Screen	Maintenance Screen window is open.	
3.4.17	Verify by review that sensor information regarding speed and direction deviation and sensor status is shown on the Maintenance Screen	Maintenance Screen indicates wind sensor information (wind speed, wind direction deviation and status) of each anemometer.	
3.4.18	Verify by review that the wind speed and directions deviation as well as sensor status is updated by each anemometer and displayed on the Maintenance Screen	The parameters are updated every 10 seconds.	
3.4.19	Verify by review that in case of sensor breakdown the operational degradation is below threshold.	A warning is displayed. Start and Stop 11 (RCS).	
3.4.20	Verify by review that the centerfield sensor is indicated.	The centerfield sensor is displayed. <i>(Color selection)</i>	
3.4.21	Verify by test: Click on any anemometer to display the temporal evolution of wind speed and direction deviation and operational degradation as well as the wind rose display and settings option functionality.	An extra screen is display can be opened to view the different functionalities.	
3.4.22	Verify by testing the system can manually isolate the remote site from system calculation when its data becomes faulty or abnormal; however the speed and	The sensor can be isolated.	

	direction data shall still be shown. The operator can manually accept the sensor and include it in calculation once it has recovered.		
3.4.23	<p>Verify by review that analysis, calculation and statistics on wind speed and wind direction data has been made. Meanwhile, basing on comparing the accuracy of the information and reasonability in the past data, determine the credibility of wind speed and direction in current anemometer</p>	The Req. is fulfilled.	OK
3.4.24	<p>Verify by testing that the maintenance screen is able to display wind speed, wind direction and measured the average wind speed and wind direction in system of each anemometer, and can be showed in tabular form.</p> <p>Verify by testing that the maintenance scree is able to display the wind rose drawing of each anemometer, and each one of the wind rose drawing can be selected by quarter, month, day, or by specifying the time interval screening.</p> <p>According to selected sites and counted by quarter, month, day, or by specifying the time interval to filter out and display wind shear data, and can show them in tabular format.</p>	The Req. is fulfilled.	✓

3.4.25	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	✓
3.4.26	Verify by review that out of service time of anemometers are recorded.	The out of service time is recorded.	✓
3.4.27	Open the LLWAS report screen.	The LLWAS report screen is open.	✓
3.4.28	Check that all anemometers and wind measurements are displayed on textual basis and the Network Mean is calculated.	All installed anemometers displaying wind information.	✓
3.4.29	Verify by review that in case of anemometer/s break down an alert will be indicated (visual red sign)	A red point indicates an anemometer error.	✓
3.4.30	Verify by review that in case of anemometer/s break down the failed sensor will be indicated	The failed anemometer is displayed.	✓
3.4.31	Verify by review that wind shear alerts are displayed (textual basis). The alerts has to specify: <i>Wind Shear - Loss/Gain Microburst - Loss Location on RWY</i>	A warning triangle is displayed when an alert is generated. A click on the triangle and the alert is specified according to LLWAS Phase 3 requirements. <i>- WSA not presented due to Test data - Check SAT WSA</i>	✓ to Test data
3.4.32	Check the Online Help function Using the corresponding symbol inside RainShear Display	The Rainbow Software Online Help is available	✓
3.4.33	Check the setting function to filter results to be visualised. - Anemometer Errors - Wind Shear Alerts - Normal conditions - All	The filter function works on required performance. <i>Overlay removed</i>	✓
3.4.34	Check the data archive function (click on database icon) for anemometer data and wind shear alerts. - select start and end time	Within the selected time frame all data can be visualized.	✓

	- start data request		
3.4.35	Check the export function (click on button export) to export displayed data into an external XML file showing MBA and WSA alerts and Centerfield data.	Data are exported into an external file. <i>ANWS will format for Multicast</i>	✓
3.4.36	Verify by test to switch back to RainShear start-up screen.	The start-up screen will be displayed.	✓
3.4.37	Verify by review that System Cycle time of the server in main station is less than 10 seconds including first gets the wind speed and direction from the remote anemometer, processes, produces the shear/microburst/burst alert, finally shows the situation on the workstations and records it in the database.	The system cycle is 10 sec.	✓
3.4.38	Open the System-log screen.	The System-log screen is open.	✓
3.4.39	Verify by review that in case of status "System Support" a log-message will be shown and stored.	The log-message is stored accordingly.	✓
3.4.40	RainShear Status Update (RainRCS) - indicates the status of the server system. Verify by review that in case of a RainRCS process is not running a message will be indicated. A click to RainRCS and it is indicated which process is 'Down'. The following processes are shown: 1. NGS (News Group Server Communication) -	Indicates Up/Down	

	<p>communication of LLWAS components</p> <p>2. RainRLS (RainLogServer) – messages can be logged or not</p> <p>3. PostgreSQL – observation of Rainbow® data base (directory, files etc)</p> <p>4. RainDbAdmin – data base observation</p> <p>5. RainAWOSImport– test program for reading AWOS data</p> <p>6. EmometerImport – anemometer data input</p> <p>7. RainLLWAS – algorithm kernel (observation of algorithm)</p> <p>8. RainDTCim – data import from DTC</p> <p>9. elnetServer.py process to receive AWOS data to server</p> <p>10. elnetClient.py process to transmit AWOS data to client</p> <p>11. AnemometerData anemometer data input</p>	<p>Indicates Up/Down</p>	<p>✓</p>
3.4.41	<p>RainSCOUT log. message – In case of a wind shear/ microburst alert is indicated to the controller within RainScoutATC client he has the possibility to acknowledge the alert.</p>		<p>✓</p>

	Verify by test to acknowledge a wind shear/microburst alert at the workstation/client computer	A log-message will be generated that the alert is acknowledged.	✓
3.4.42	<p>RainLLWAS log. message shows all status information regarding the LLWAS algorithm.</p> <p>Verify by review:</p> <ul style="list-style-type: none"> - when the system is degraded but LLWAS is able to run, a warning shall be indicated "yellow sign" - when system support is needed, LLWAS is not able to run, an alert is generated "red sign" - the system has no data (LLWAS is off) an alert is generated "red sign" - the initialization is in process "green sign" 	The corresponding log-messages are generated. (stop DTCsim)	✓
3.4.43	<p>Click on the green arrow on bottom on the left to verify:</p> <ul style="list-style-type: none"> - the RainShear version number - on-line help - options 	The function is working properly.	✓
3.4.44	Verify by test to switch back to Rain Shear startup screen.	The start-up screen will be displayed.	✓
3.4.45	Verify by review that the out of service interruption time, and communication failure status in system is logged.	The corresponding message is logged.	✓
3.4.46	Verify by review that self-diagnosis capability is available. When a malfunction of system or		

	sensor or no signal, system must show a screen alarm and audible alarm. (The alert sound can be switched ON/OFF). The types of malfunction etc., shall be displayed and recorded in the servers		✓
3.4.47	Starting RainScoutATC using the Icon	RainScoutATC is open.	✓
3.4.48	Verify by test that RWY mode is selectable.	Application allows to switch between RWY modes.	✓
3.4.49	Check the LLWAS System status which will be indicated in RainShear: Real time normal (green) Real time degraded (yellow) System Support (red) Initialization (yellow) Off (red)	This status should indicate when all anemometers 16 deliver wind data. Some anemometers 15-14 break down but LLWAS still operating. To few anemometers out of order 13 - 0 the LLWAS is not able to operate The LLWAS will be initialized (e.g. after restart) No Anemometer and also no RS status for more than n seconds (n is configurable)	✓
3.4.50	Verify by review that data are available and fonts are readable on display	The design corresponding the user needs.	✓
3.4.51	Verify by review that the LLWAS CF wind data and alternates are available	CF winds are available and alternate winds are provided if the primary is out of scan	✓
3.4.52	Verify by review the graphical mode functionalities of the RainscoutATC display: - specific data messages	All example data formats are correctly displayed on the ATC displays	

	<p>show the following conditions in the correct format WINDSHEAR (WSA) → check during SAT MICROBURST (MBA)</p> <ul style="list-style-type: none"> - RWY incl. 3 NM are displayed - In case of WSA and MBA the location and intensity is displayed - an alarm message is indicated when a WSA or MBA is detected - an alert sound when a WSA or MBA is detected 		✓
3.4.53	<p>Verify by test that the alert can be acknowledged</p>	The alert sound is muted.	✓
3.4.54	<p>Click on the setup button to verify the setting function:</p> <ul style="list-style-type: none"> - version number - on-line help - font size setting - print function - save function - zoom function 	The setting functions working reliable.	✓
4.3.55	<p>Verify by testing that the operator is able to select which runway information shall be displayed and the rest are not be displayed</p>	The specific RWY will be displayed.	✓
3.4.56	<p>Click to the button to switch to the AAD display showing the alerts on textual basis</p>	The Ribbon display is opened.	✓
3.4.57	<p>Verify by review that the LLWAS RWY threshold wind data are available:</p> <ul style="list-style-type: none"> - RwyA (arrival) - RwyD (departure) - etc. for each runway 	<p>RWY threshold winds are available and alternate winds are provided if the primary is out of scan. Threshold from AWOS</p>	✓
3.4.58	<p>Verify by review that an alert is indicated when a</p>	The alert information are displayed.	

	WSA or MBA is detected containing the information: - RWY Departure/Arrival - Location - WSA or MBA	<i>WSA on site</i>	✓
3.4.59	Verify by review that 200 NEDGES and 250 NTRIANGLES can be processed.	The Req. is fulfilled	✓

Step	Action	Expected Results	Check
3.4.60	Verify by testing the wind shear events rebuilt and replay functionality at each available workstation showing each wind tower warning status , Alarm Area, Wind Field Analysis and AAD, GAD alarm display	The Replay function is working properly.	✓

4. Verification of the LLWAS algorithm

Objektives:

Software testing verifies that the system software is correctly installed and that it is operating correctly. It will be visually checked that the software configurations match the required site descriptions for the respective airport.

Files to Check:

- acf.txt
- Station configuration file
- Display configuration file

Step	Action	Expected Results	Check
4.1	Verify that the runway direction, latitude, and longitude are as specified.	Examine settings and acf.txt values; compare with the approved list of airport latitude longitude specifications*	✓
4.2	Verify that the latitude and longitude of wind sensor sites are as specified.	Examine settings and acf.txt values; compare with the approved list of airport latitude longitude specifications*	✓

4.3	Verify that Centerfield sensor and alternates are correctly specified.	Examine the RainLLWAS.ini file; compare with the approved list of threshold sensors and alternates*	✓
4.4	Verify that the RWY threshold sensors and alternates are correctly specified.	Examine the RainLLWAS.ini file; compare with the approved list of threshold sensors and alternates*	✓

* The approved list of airport site information will incorporated into this document

5.LLWAS data archive function test

Objektives:

Verify the operation of data archive functions.

General:

The archive function is included into RainShear. The archive function is available for LLWAS textual alert messages and for system status messages.

Step	Action	Expected results	Check
5.1	Verify that history data are stored and can be opened as specified.	History files have been saved and can be opened and displayed.	✓
5.2	Verify the content of the history files.	<ul style="list-style-type: none"> - Time and Date - Wind Data - WS Alerts - MB Alerts - System Status 	✓
5.3	Verify the export of the history files	History files can be exported in XML format	✓
5.4	Verify by test the possibility to open and display archived events within RainShear. The following information shall be contained: <ul style="list-style-type: none"> - ability to access to the archived data of files every time - ability to operationally filter the archived data as form of alerts 	All functions are working reliable.	

	- ability to display the status of the LLWAS system during archive request		✓
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6.NCAR Comparison Tests

Objektives:

Verify the operation of LLWAS algorithm by comparison with NCAR (The National Center for Atmospheric Research) test data.

- NCAR test sets are developed by NCAR for evaluation purposes. Each set contains an ACF file for a simulation airport, input wind data, and Alert messages produced by the NCAR LLWAS implementation.

Test Procedure:

Testing is done by using input files furnished by NCAR (including configuration files) and comparing the resulting alerts pr with alerts produced by the *Selex ES GmbH* LLWAS implementation.

- The NCAR test data are located in the data archive. It is necessary to load the correct configuration files and to access the correct wind data file. The NCAR wind data are processed by the LLWAS algorithm through the Playback utility in step mode, and the alert message results are compared with the alerts from the NCAR archive.
- Use cks_14.acf, cks_14_b.dat , and compare with cks_14_b.alert.

From cks_14_b.alert:

Time:	6 21 20 5 40	Check
06A	WSA +15k 2MF Psbl WS OTSD	
24D	WSA +15k 1MD Psbl WS OTSD	

Time:	6 21 20 5 50	Check
06A	WSA +15k 2MF Psbl WS OTSD	
24D	WSA +15k 1MD Psbl WS OTSD	

Time:	6 21 20 6 0	Check
06A	WSA +15k 2MF Psbl WS OTSD	
24D	WSA +15k 1MD Psbl WS OTSD	

Time:	6 21 20 6 10	Check
06A	WSA +15k 2MF Psbl WS OTSD	
24D	WSA +15k 1MD Psbl WS OTSD	

Time:	6 21 20 6 20	Check
05A	MBA -30k 2MF	
23D	MBA -30k 2MD	
06A	MBA -30k 2MF	
24D	MBA -30k 2MD	

Time:	6 21 20 6 30	Check
05A	MBA -30k 2MD	
23D	MBA -30k 2MD	
06A	MBA -30k 2MF	
24D	MBA -30k 2MD	

Time:	6 21 20 6 40	Check
05A	MBA -35k 2MF	
23D	MBA -35k 2MD	
06A	MBA -35k 2MF	
24D	MBA -35k 2MD	

~~ASAC: PTT~~

The LLWAS FAT has been performed satisfactorily and witnessed by the following people representing the following authorities:

Performed by

Signature

江世忠 2014.7.17.

陳冠華 2014.7.17

Dr. René Grafelt (Selex PM)  17.07.14

張蒼民 2014.7.17

Date: