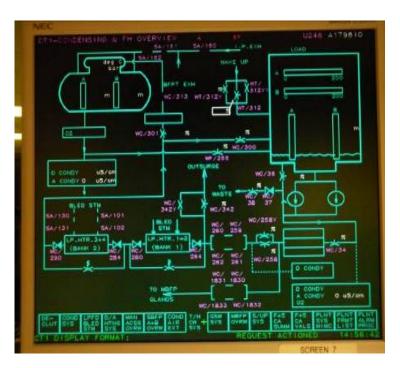
TSP/PLANT/055/2 Revision 002 Oct 2015

### ENERGIFORSK SEMINAR October 2016

'Management & Maintenance of a Legacy (but Critical) Data Processing & Control System' A. Milne (System Engineer)



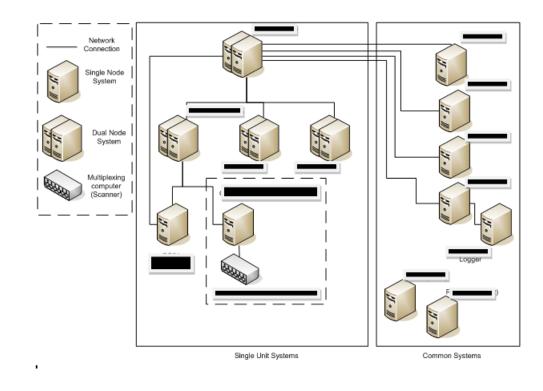




1 Torness Equipment Reliability System Review

## **Description of system**

Torness Power Station DPCS (Data Processing & Control System) provides two main areas of functionality. The Data Processing System (DPS) presents alarms and plant information to control room engineers. The Auto Control (AC) system operates a number of auto control loops e.g. T2 control. Both DPS & AC play significant roles in operational safety (i.e. are safety claimed/critical) with some failure conditions potentially resulting in reactor trip (i.e. failure to comply with safety regulation).





# **History of system**

The DPCS system (Ferranti) was designed in the 1970s/80s & is still in operation (with many original never replaced modules that now beyond MTBF). The system was initially used by the UK MOD for missile targeting/tracking but has been used in various military and industrial applications globally. Typically the hardware and operating system remained common whilst software applications have been tailored for use.

Although the underlying COTS system was used in various international locations and organisations (as far afield as India), there is now only one other known industrial user with the UK MOD having replaced their systems tens of years ago.

#### Replace versus Retain

With regards to Torness power station an ALARP review was carried out between 2009-2011 with the end decision to retain the existing legacy system until end of station life (2030+4). Factors in the decision making included the cost, time & risk of any potential replacement balanced against the ability to maintain performance of the existing legacy system to the end of station life.

This approach has been communicated to the UK regulator and a process of substantiation has been put in place.

The substantiation revolves around known failure rates, sufficient spares, close monitoring of failures, identification of 'outwith normal' trends and sufficient forewarning of any unforeseen age related problems to provide time to either procure more spares and/or reengineer a solution.

Regular reviews have continually reported the DPCS as operating within original design expectations (availability & integrity) with various OPEX suggesting reliability is at a peak.





# **Challenges & Supporting Factors**

### Legacy System Challenges

Obsolete DPCS (i.e. cannot purchase replacement HW modules). DPCS replacement estimated to be £70M+, 7+ yrs development. Legacy software programming language and tools obsolete. Increasing commercial drive to improve system reliability. Increasing regulator requirements (especially in computer security). First & Second Line maintenance 'knowledge gap' – system 'grey beards' retired/approaching retirement.

### **Supporting Factors**

System perceived as reliable, fail rates within design expectations. Although new modules cannot be obtained, most faults are repairable. Although the OEM no longer exists, the core OEM team is still available.





# **Support & Maintenance Strategy**

"..... the ability to maintain performance ... to the end of station life..."

Can our approach work ? How do we check ?

In order to validate *availability* & *reliability*, several key programs were identified:

- Fault and Failure (F&F) Analysis
- Spares Analysis
- Obsolescence Analysis
- SQEP reinforcement and monitoring
- Supply Chain Analysis

To continue to provide the same levels of DPCS capability it was recognised the capability <u>to change</u> the system should be supported. This includes both

- Software changes
- Hardware changes





### Availability & Reliability (1) -

### **Spares, F&F and Obsolescence Analysis**

### Spares Analysis (SAR)

- How many do we have ?
- Which modules ?
- Are there enough (forecasting)?
- Do the spares work ? Storage?

### **Fault & Failure Analysis**

- Failure rates per module/location trends?
- Which components are failing?
- Supports SAR forecasting
- MTBF/Industry OPEX

### **Obsolescence Analysis**

- What components are used in each module (prioritisation)
- Still available/modern 'qualified' equivalent ?
- Supports Repair Loop (spares planning)





### Availability & Reliability (2) -

### **SQEP Reinforcement, Supply Chain Analysis**

### **The People**

- Which people ? When ?
- How many do we have ? What it the age profile ?
- What skills do they have ? gap?
- How best can knowledge be imparted ?

### **The Organisations**

- Strategic view 'outsourcing' v 'insourcing'
- Blue chip reputation what is it ?
- Overall business dependency on 'our business'
- 'Insurance' versus 'flexibility'
- Contracts





# **Underpinning Tools & Techniques (1)**

Asset Management Tool - Asset Guardian (data visibility & accuracy) COTS 'plain' Asset Management System – strong tailoring capability System customised following detailed Use Case requirements phase Replaced several previous ad-hoc & unconnected systems Full configuration control linked with 'activity' tracking & repair loop. 'One fits all' solution used for software & auditing (e.g. computer checks) Provides 'easy' GUI to analyse data – several KPI reports created

<u>Culture (attitude) – Fault diagnostics, resolution & tracking</u> Intolerance of failure v 'it's always been like that' (focus on faults) Closely monitor failures – ensure 'closed loop' wart repair loop understanding Use of AMS tool to properly record & document changes

#### **SQEP planning**

What are the key local support skills ? Appetite for staff headcount changes Retirement plans – how committed ? SQEP 'Redundancy' Strategic view

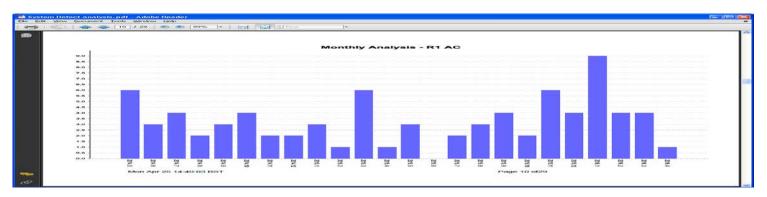
Documentation & review All reports updated and reviewed by extended group involving local station 'grey beards', CTO & Vendor. Rigorous review process. Analysis & summary carried out on annually.

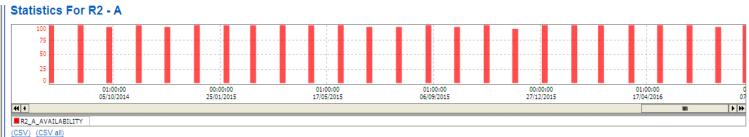
### **Questioning attitude at all stages**





# Underpinning Tools & Techniques (2) System Availability





							A	vailability						
Y	ear	January	February	March	April	May	June	July	August	September	October	November	December	Total
21	016	100.00	99.97	100.00	100.00	100.00	100.00	100.00	0.00	0.00	0.00	0.00	0.00	<u>100.00</u>
20	015	99.98	99.98	100.00	99.99	100.00	100.00	96.77	100.00	99.99	100.00	96.67	100.00	99.45
21	014	100.00	99.93	100.00	99.91	100.00	100.00	99.97	100.00	100.00	99.98	100.00	100.00	99.98
20	013	99.98	100.00	100.00	100.00	100.00	100.00	100.00	100.00	99.99	100.00	100.00	100.00	100.00
(re	eset)	Show Slots												





# Underpinning Tools & Techniques (3) Asset Management System

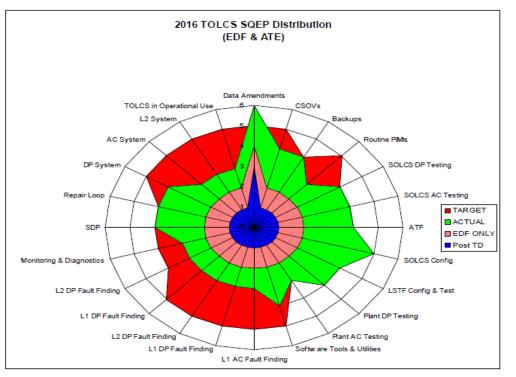
Assets V +7 Al Assets Software Dudy Experiment Software Builds Software Updates SPRs Modification Requests Hardware Change Requests Proprietary Software Module Types Users Audit Hoto DBIDD Barrwood BIDD Partment Software Module Types Users Audit Hoto	Database Edit Go	Action Favouri	tes Tools	Tabs Help	7 47 0			🐟 िस्त झि		[1723]	R2			
Other Service       Packet Status       Consequences       CERSI Services       CERSI Services       Propriet       Robult Status         Diff.       Status       Note       Status       Note       Status       Note       Note       Status       Note       Note <th></th> <th></th> <th></th> <th></th> <th></th> <th>Lern. L. H</th> <th>differentiane i Barana anta</th> <th></th> <th></th> <th></th> <th></th> <th>Conflormation Control</th> <th>E Hardenau II H</th> <th>and day</th>						Lern. L. H	differentiane i Barana anta					Conflormation Control	E Hardenau II H	and day
DWD       D														
Dit       Asset       Republic V       Policity Policy       Security Policy       Status       Notes         Dit       Total       Dit       Policy	BWD - Barnwood			MR	122						RETURNED	1		(
PD::::Torset::Construct       PD::::Torset::Construct       PD::::Torset::Construct       PD:::::Torset::Construct       PD::::::::::::::::::::::::::::::::::::	🗀 EKI - East Kilbride		Locat	Repair ID *	Module Type	Serial No.	Ea	ult Description			Status	Notes		-
International United United View Processing Construction       International View Processing		C TOD F21 TO												
0       CODE_21.704.51.18.10.6.0.0       PP14070       MP122       1555       Fan utgenetics       Part Utgeneits       Part Utgenetics		(0) 🦰 TOD E21 ET							y raise/clear					
Order       Control       Perform		TOR.E21.TC												
• TOR.221 TOCS.11.81 - Res.         BP14000         • PB14000         • PA122         1642         • Pars intermittently inter optimizing some memory by Risk         • Pars intermittently inter optimizing some memory by Risk         • Pars intermittently inter optimizing some memory by Risk         • Pars intermittently inter optimizing some memory by Risk         • Pars intermittently interview intervi													_	
• TOR.221.TOLS.11.R1.C.COX         P140259         P140259         P140259         P14025         TOR.221.TOLS.11.R2.C.COX         P140299         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P140399         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P140399         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P140399         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P14039         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P14039         P14122         1074         Par uns steed         TOR.221.TOLS.11.R2.C.COX         P14039         P14122         1074         Par uns													·	
TOR.221.10LCS.LIN.22.C3.40       PR04400       PR122       1738       Pannag system and fase not rotating properly.       C.G.I.       RETURNED         TOR.221.10LCS.LIN.22.ADM       PR04580       PR122       600       Maining system and fase not rotating properly.       G.G.I.       RETURNED         TOR.221.10LCS.LIN.22.ADM       PR04580       PR122       600       Maining system and fase not rotating properly.       G.G.I.       RETURNED         TOR.221.10LCS.LIN.22.CCI       PR04580       PR122       107       Pannet system is a long the total system is a long the tota														
Image: Display: D								any to span reamon	ou by rer lat					
• TORLE21_TOLES1_L25_SLAVO         PRO303         ME122         1660         FARD_SLAVD_moreowetch         Coll         RetURNED         TORLE21_TOLES1_LR2_CC1         PRO303         ME122         1918         PRO403         FARD_SLAVD_MOLE         PRO403         ME122         1918         Menowetch mutabalang fan fal alarm.         Coll         RetURNED         TORLE21_TOLES1_LR2_CC1         PRO303         ME122         1918         Menowetch mutabalang fan fal alarm.         Coll         RetURNED         TORLE21_TOLES1_LR2_CC1         PRO403         ME122         102         PRO403         TORLE21_TOLES1_LR2_CC1         PRO403         ME122         102         PRO404         TORLE21_TOLES1_LR2_CC1         REVEAU         ME122         102         TORLE21_TOLES1_LR2_CC1         REVEAU         ME122         102         TORLE21_TOLES1_LR2_CC1         REVEAU         ME122         102         TORLE21_TOLES1_LR2_CC1         REVEAU         TORLE21_TOLES1_LR2_CC1         REVEAU         ME122         102         TORLE21_TOLES1_LR2_CC1         REVEAU         ME12		OR.E21.TC	LCS.L2.PS.BAY0	RP68439	MR122		Burning system and f	ans not rotating pro	perly.		RETURNED			
Concept 10.025.11.82.021     Ref40383     Mi122     ID64     Fan not starting up properly, takes along time to real     Ref TURNED     TOR.221.70105.11.82.001     Ref8270     Mi122     IB49     Microsouth not installing fan fal alarm.     Cal     RETURNED     Concept 10.00								oise.						
0       TOR.E21.TOLCS.LI.R.L.CCC       RFR63022       M1122       91/FR4248       M1000000000000000000000000000000000000								annada, baban a lana						
© TOR.221.0TORES.MAIN.OLC       EP68270       MR122       1849       Microsortch not initializing fan fal alwrm.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLC       EP68249       MR122       528       Pan falled. Overhull required.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLC       EP69247       MR122       528       Microsortch not violing correctly. D Roll Removed his.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLC       EP69247       MR122       520       Microsortch not violing correctly. D Roll Removed his.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS       EP692479       MR122       520       Fan not violing correctly. D Roll Removed his.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS       EP69560       MR122       2795       Fan not violing correctly. D Roll Removed his.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS       EP69560       MR122       2796       Fand stiff to tate.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS       EP69560       MR122       2796       Fand stiff to tate.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS       EP694632       MR122       1647       Fan stiff to tate.       Call       RETURNED         © TOR.221.0TORES.MAIN.OLCS									g time to rea					
© TOR.R21.70LCS.L1.R2.CCC       PR68249       MR122       1676       Pan fal alem standing - fan motor seized - reguland.       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR68249       MR122       330       Microsettich not working. Fan are rotating ob but fan.       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR68249       MR122       1635       Microsettich not working or reguland.       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR68244       MR122       1635       Motor motory.       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR69644       MR122       2635       Fan notes select       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR69648       MR122       2645       Pan notes select       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR69648       MR122       2646       Pen.stick       Call       RETURNED         © TOR.R21.TOLCS.L1.R2.CCL       PR69489       MR122       1647       Fan stiff to turn.       Call       RETURNED         © TOR.R21.TOLCS.L1.R1.CCC       RP49430       MR122       1649       Pan stiff to turn.       Call       RETURNED         © TOR.R21.TOLCS.L1.R1.CCC       RP49439       MR122       1649       Pan stiff to turn. <td></td>														
TOR.E21.TOLCS.IL.R2.CCLI       PP04799       MR122       200       Microswitch not working (Fan are notating ok but fa.       Call       RETURNED         OT OR.E21.TOLCS.IL.R2.CCD       PP05402       MR122       1635       Motor moly.       Call       RETURNED         OT OR.E21.TOLCS.IL.R2.CCD       PP05402       MR122       2233       Fan motor seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R2.CCD       PP05402       MR122       2233       Fan motor seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R2.CCD       RP05403       MR122       2243       Fan motor seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R2.CCD       RP04483       MR122       2647       Fan seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R1.CCD       RP24812       MR122       1646       Pan seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R1.CCD       RP24813       MR122       1646       Pan seized.       Call       RETURNED         OT OR.E21.TOLCS.IL.R1.CCD       RP24818       MR122       1646       Pan seized.       Call       RETURNED       Call       RETURNED         OT OR.E21.TOLCS.IL.R1.CCD       RP24818       MR122       1647       Fan seiif do outor over law cloupide over law cloupide					MR122	1676			I - replaced.	Cal	RETURNED			
Image: Tot R_221_TOLCS_LLR_2_CCOR       RP67479       MR122       030       Fan not working correctly, D Role Removed this.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_2_CCOR       RP65664       MR122       2233       Fan motor selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_2_CCOR       RP65664       MR122       2392       Fan motor selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_2_CCOR       RP64682       MR122       2392       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_2_CCOR       RP64683       MR122       2097       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_2_CCOR       RP64683       MR122       2096       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_LCCOR       RP24693       MR122       1694       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_LCCOR       RP24693       MR122       1694       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_LCCAR       RP24939       MR122       1694       Fan selend.       Call       RETURNED         Image: Tot R_221_TOLCS_LLR_LCCAR       RP24939       MR122       1694       Fan selend.       Call<														
Or TOR, 221, TOLCS, LL, R2, COOR       RP65604       M122       2263       Prom motors setted.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP65466       M122       2293       Pault - Motor very noisy.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP65466       M122       2392       Pault - Motor very noisy.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP65486       M122       2392       Pault - Motor very noisy.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP65483       M122       266       Dead.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP24831       M122       1694       Pan stiff to rotate.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP24433       M122       1647       Fan stiff to rotate.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP24430       M122       1649       Removed from RLCS BAYS. Motor stuck. Fon fall mec.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, COL       RP24303       M122       1649       Removed from RLCS BAYS. Motor stuck. Fon fall mec.       Col       RETURNED         Or TOR, 221, TOLCS, LL, R2, CoL       RP24305       M122														
Index Sci. 10.01_Sci. 11.82.1_CC0       RP65460       MR122       2392       Peak - Motor very noisy.       Col       RETURNED         Index Sci. 10.1_Sci. 11.82.2_CC0       RP65466       MR122       2392       Peak - Motor very noisy.       Col       RETURNED         Index Sci. 11.82.1_LTR       RP65468       MR122       2266       Dead.       Col       RETURNED         Index Sci. 11.81.2_CC0       RP24532       MR122       1664       Fan stiff to rotate.       Col       RETURNED         Index Sci. 11.81.2_CC0       RP2453       MR122       1664       Fan stiff to rotate.       Col       RETURNED         Index Sci. 11.81.2_CC0       RP24473       MR122       1654       Fan stiff to rotate.       Col       RETURNED         Index Sci. 11.81.2_CC0       RP24430       MR122       1554       Fale onjoff over last couple of weeks.       Stil working.       Col       RETURNED         Index Sci. 10.1_CS1.1.81.2_CC0       RP24430       MR122       1657       Flow subtch sticking.       Col       RETURNED       RETURNED         Index Sci. 10.1_CS1.1.81.2_CC0       RP24058       MR122       1651       Fan staff to notate.       Col       RETURNED       RETURNED         Index Sci. 10.1_CS1.1.81.2_CC0       RP24058       MR122								ectly. D Rollo Remov	red this.					
O TOR.#21.TOLCS.LI.#2.CCUI       RP65486       MR.122       292       Fault - Motor very noisy.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP65483       MR.122       2060       Dead.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP65483       MR.122       2266       Dead.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP24581       MR.122       1649       Pan staff to turn.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP24430       MR.122       1549       Paled on/Or ver last couple of weeks. Stil working.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP24430       MR.122       1549       Paled on/Or ver last couple of weeks. Stil working.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP24430       MR.122       1549       Paled on/Or ver last couple of weeks. Stil working.       Cal       RETURNED         O TOR.#21.TOLCS.LI.#2.CCUI       RP24438       MR.122       1549       Remain accuritation acuritation acuritation accuritation accuritation														
TOR.#21.170LC5.L1, R2.CC00 RP46493 MR.122 266 Dead. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1644 Fan stiff to rotate. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1647 Fan stiff to rotate. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1547 Fald onjoff over last couple of weeks. Stil working. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1547 Fald onjoff over last couple of weeks. Stil working. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1547 Fald onjoff over last couple of weeks. Stil working. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC00 RP24493 MR.122 1547 Flow switch sticking. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC03 RP24493 MR.122 1643 Fan failed onjoff over last couple of weeks. Stil working. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC03 RP24493 MR.122 1557 Flow switch. sticking. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC03 RP24493 MR.122 1561 Fan fald standing. Cal RETURNED   TOR.#21.170LC5.L1, R1.CC03 RP24078 MR.122 1594 Fan Link voice stal working stand the motor being burn voic Cal RETURNED   TOR.#21.170LC5.L1, R1.CC3 RP24064 MR.122 1594 Fan Link voice stal working stand the motor being burn voic Cal								isv.						
TOR.22.1.101.CS.LI.R1.CC00       PP24493       NR122       1644       Pan stiff to rotate.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC00       PP24493       NR122       1647       Pan stiff to turn.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC30       PP24490       NR122       1547       Planded on/off over last couple of weeks, Still working.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC30       PP24425       MR122       1649       Pan failed on Johns. DEAD.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC0       PP24635       MR122       1649       Pan failed on Johns. DEAD.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC0       RP24456       MR122       1649       Fon failed on Johns. DEAD.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC03       RP24456       MR122       1643       fan sized. R1 CC09.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC03       RP24405       MR122       1551       Returned head being taken       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC03       RP24046       MR122       1594       Fan Unkt defective. Jaken Alarm fault standing.       Cal       RETURNED         TOR.22.1.101.CS.LI.R1.CC3       RP24046       MR122       1594											RETURNED			
TOR.E21.TOLCS.LI.R2.CCC0     RP24493     MR122     1647     Failed on/Power last couple of weeks. Status Ranking Call     RETURNED     TOR.E21.TOLCS.LI.R2.CCC0     RP24493     MR122     1649     Removed from RICS BAY 5. Motor stude, Fain fail mee     Call     RETURNED     TOR.E21.TOLCS.LI.R2.LCC0     RP24493     MR122     1649     Removed from RICS BAY 5. Motor stude, Fain fail mee     Call     RETURNED     Call     RETURNED     TOR.E21.TOLCS.LI.R2.LCC0     RP24435     MR122     1649     Removed from RICS BAY 5. Motor stude, Fain fail mee     Call     RETURNED     Replaced by technician are     Call     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     Call     RETURNED     RETURNED     Calll														
TOR.E21.TOLCS.LI.P.2.CC00       PP24400       MR122       554       Felde on/diff over last couple of weeks. Still working       Call       RETURNED         CTOR.E21.TOLCS.LI.P.1.CC0       PP24405       MR122       1649       Removed from RCS BAY St. Motors stude. Fond lattice for the sticking.       Call       RETURNED         CTOR.E21.TOLCS.LI.P.1.CC0       PP24405       MR122       1641       Fond lattice fond plant- DEAD.       Call       RETURNED         CTOR.E21.TOLCS.LI.P.1.CC0       PP24405       MR122       1663       fon sizead. R1 CC09.       Call       RETURNED         CTOR.E21.TOLCS.LI.R.1.CC0       RP24405       MR122       1663       fon sizead. R1 CC09.       Call       RETURNED         CTOR.E21.TOLCS.LI.R.1.CC0       RP24405       MR122       1561       fon sizead. R1 CC09.       Call       RETURNED         CTOR.E21.TOLCS.LI.R.1.CC0       RP24076       MR122       1594       Fon luft defective. Jaarn fault standing.       Call       RETURNED       RETURNED         CTOR.E21.TOLCS.LI.R.2.CC3       RP24046       MR122       1594       Fon luft defective. Jaarn fault standing.       Call       RETURNED       Replaced by technician ar         CTOR.E21.TOLCS.LI.R.2.CC3       RP24064       MR122       1594       Fon luft defective. Jaard       Call       RETURNED														
TOR.E21.TOLCS.LI.R.I.C.S.B. PP24329     MR.I22     I575     Flow switch skicking.     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24363     MR.I22     I514     Fon variable skicking.     Col. RETURNED     Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24363     MR.I22     I514     Fon failed on plant. DEBAD.     Col. RETURNED     Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24363     MR.I22     I534     General confidence tests due to module being taken1     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP2436     MR.I22     I534     General confidence tests due to module being taken1     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24363     MR.I22     I534     General confidence tests due to module being taken1     Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP2406     MR.I22     I534     General confidence tests due to module being taken1     Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24065     MR.I22     I537     Seadd.     Col. RETURNED     Col. RETURNED     Col. RETURNED     Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24064     MR.I22     I537     Np power showing signs of the motor being burnt out, Col. RETURNED     Col. RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RP24064     MR.I22     I537     Np power showing signs of the motor being burnt out, Col. RETURNED     TOR.E21.TOLCS.LI.R.I.R.COM     RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RETURNED     TOR.E21.TOLCS.LI.R.I.C.COM     RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R.I.C.C.C.M.RETURNED     TOR.E21.TOLCS.LI.R								t coursie of weeks	Still working					
TOR.E21.TOLCS.LI.P.I.COC       RP24025       NR122       1614       Fan failed on plant- DEAD.       Cal       RETURNED         TOR.E21.TOLCS.LI.P.I.COC       RP2405       NR122       1643       Fan failed on plant- DEAD.       Cal       RETURNED         TOR.E21.TOLCS.LI.P.I.COC       RP24105       NR122       1663       fan sizead. RI CC09.       Cal       RETURNED         TOR.E21.TOLCS.LI.P.I.COC       RP24105       NR122       1561       RINuc O- Ser Non 1049: Fan fails alarm operating       Cal       RETURNED         TOR.E21.TOLCS.LI.P.I.COC       RP24076       NR122       1551       RINuc O- Ser Non 1049: Fan fails alarm operating       Cal       RETURNED         TOR.E21.TOLCS.LI.P.I.COC       RP24046       MR122       1574       Fan unt defective. Alarm fault standing.       Cal       RETURNED       Replaced by technician ar         TOR.E21.TOLCS.LI.P.S.EAV       RP24064       MR122       1574       Fan on the but paddle causing alarm operating       Cal       RETURNED       Replaced by technician ar         TOR.E21.TOLCS.LI.P.S.EAV       RP24064       MR122       1574       Fan on - but paddle causing alarm operating       Cal       RETURNED       Replaced by technician ar         TOR.E21.TOLCS.LI.R.I.COL       RP23060       MR122       1571       Fan on - but paddle causing alarm fai														
Cal RETURNED TOR.E21.5TORES.MAIN.NOLC RP24195 MR.122 1663 fan siezed. R.1 CO9. Cal RETURNED TOR.E21.5TORES.MAIN.*CT RP24105 MR.122 1561 R.1 May O-Ser No. 1049: Fan fals alarm operating Cal RETURNED TOR.E21.7 TOR.E21.5TORES.MAIN.*CT RP24078 MR.122 1571 Seized. TOR.E21.7 TOR.E21.5TORES.MAIN.*CT RP24078 MR.122 1571 Seized. TOR.E21.7 TOR.E21.5TORES.MAIN.*CT RP24078 MR.122 1571 Seized. TOR.E21.7 TOR.E21.7 TOR.E21.5 LIR.E.COS RP24078 MR.122 1571 Seized. TOR.E21.7 TOR.E21.7 TOR.E21														
TOR.E21.STORES.MAIN.*TC       RP24105       MR122       1634       General confidence tests due to module being taken I       Call       RETURNED         Confraction       RETURNED       RETURNED       Call       RETURNED       RETURNED         Confraction       RETURNED       RETURNED       Call       RETURNED       RETURNED         Confraction       RETURNED       RETURNED       RETURNED       Returnen         Confraction       RETURNED </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>EAD.</td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>								EAD.						
TOR.R.2.1. TOLCS.LI.R.1.CCC0       RP24078       MR122       1561       R.1 Mux O- Ser No in 1648- FAn falls alarm operating i Cal       RETURNED         Contract_1.TOLCS.LI.R.1.CCC0       RP24064       MR122       1574       Seized.       Cal       RETURNED       Replaced by technician ar         Contract_1.TOLCS.LI.R.1.CC3       RP24064       MR122       1574       Fan Unit defective. Alarm fault standing.       Cal       RETURNED       Replaced by technician ar         Contract_1.TOLCS.LI.R.2.CC1       RP24064       MR122       1571       No power showing signs of the motor being burnt out. Cal       RETURNED       Replaced by technician ar         Contract_1.TOLCS.LI.R.2.CC1       RP23080       MR122       1571       Fon Ac- but paddle causing alarm fault.       Cal       RETURNED       Replaced by technician ar         Contract_1.TOLCS.LI.R.2.CC1       RP23080       MR122       1561       Fon Ac- but paddle causing alarm fault.       Cal       RETURNED         Contract_1.TOLS.LI.R.2.CC1       RP23081       MR122       1648       Faulty microsovitch on Arflow switch.       Cal       RETURNED         Contract_1.TOLS.LI.R.2.CC1       RP230871       MR122       1648       Faulty microsovitch on Arflow switch.       Cal       RETURNED         Replaced by replaced by replant in thenoperatinal causing faunt in the fault in nucleis causin														
TOR.E21.TOLCS.LI.R.I.C.GS PP24065 MR122 1571 Select.     TOR.E21.TOLCS.LI.R.I.C.GS PP24064 MR122 573 No power showing signs of the motor being burnt out. Cal RETURNED     TOR.E21.TOLCS.LI.R.I.C.GS RP24064 MR122 573 No power showing signs of the motor being burnt out. Cal RETURNED     TOR.E21.TOLCS.LI.R.I.C.GS RP24064 MR122 1561 Fan dk- tubedde course glarm fault. Cal RETURNED     TOR.E21.TOLCS.LI.R.I.C.GS RP24074 MR122 1561 Fan dk- tubedde course glarm fault. Cal RETURNED     TOR.E21.TOLCS.LI.R.I.C.GS RP24074 MR122 1561 Fan dk- tubedde course glarm fault. Cal RETURNED     TOR.E21.TOLCS.LI.R.2.AGR RP23070 MR122 195 R2 Mux10. Intermittent fan fails atom. MR122 nil Cal RETURNED     TOR.E21.TOLCS.LI.R.2.AGR MB 127 168 Each failed & nutlet coursed the motor with the fails atom. MR122 nil Cal RETURNED     TOR.E21.TOLCS.LI.R.2.AGR MB 127 169 E Each failed & nutlet coursed the motor with the fails atom. MR122 nil Cal RETURNED     TOR.E21.TOLCS.LI.R.2.AGR MB 127 169 E Each failed & nutlet coursed the motor with the failed atom. MR122 nil Cal RETURNED     TOR.E21.TOLCS.LI.R.2.AGR MB 127 169 E Each failed & nutlet coursed the motor with the failed atom. MR122 nil Cal RETURNED     TOR.E21.TOLCS.LI.R.2     MB 127 169 E Each failed & nutlet coursed the motor with the failed atom. MR122 nil Cal RETURNED     MB 127 169 E Each failed & nutlet coursed the motor with the failed atom. Intermittent failed atom. Int														
TOR.E21.TOLCS.LI.P.S. BAY P24064     MR.122     S73     No power showing signs of the motor being burne out. Call     RETURNED     RETURNED     TOR.E21.TOLCS.LI.P.S. BAY     P2404     MR.122     S73     No power showing signs of the motor being burne out. Call     RETURNED     TOR.E21.TOLCS.LI.P.S.CAN     P24040     MR.122     S73     No power showing signs of the motor being burne out. Call     RETURNED     TOR.E21.TOLCS.LI.P.S.CAN     P2404     MR.122     S73     No power showing signs of the motor being burne out. Call     RETURNED     TOR.E21.TOLCS.LI.P.S.CAN     P2404     MR.122     S74     S74     MR.12     MR.2     S74     MR.12     S74     MR.12     S74     MR.12     S74     MR.12     S74     MR.12     S74     MR.12     MR.2     S74     MR.12     MR.2     MR.2     S74     MR.12     MR.2     S74     MR.12     MR.2     MR.2     MR.2     S74     MR.12     MR.2     MR.2     MR.2     MR.2     MR.2     S74     MR.1     S74     MR.1     MR.2								1040- Pan raiis alarm	operating in					
TOR.E21.TOLCS.L2.PS.BAYO       PP24046       MR122       973       No power showing signs of the motor being burnt out. Call       RETURNED         TOR.E21.TOLCS.L1.P2.A.BA       PP23060       MR122       1561       Fan ok-burg signs of the motor being burnt out. Call       RETURNED         TOR.E21.TOLCS.L1.P2.A.CB       PP23067       MR122       195       R2 Mux10. Intermittent fan fails alarm. MR122 mill       Call RETURNED         TOR.E21.TOLCS.L1.P2.A.CCI       RP23067       MR122       195       R2 Mux10. Intermittent fan fails alarm. MR122 mill       Call RETURNED         TOR.E21.TOLCS.L1.P2.CCI       RP23077       MR122       195       R2 Mux10. Intermittent fan fails alarm. MR122 mill       Call RETURNED         TOR.E21.TOLCS.L1.P2.CCI       RP23077       MR122       164       Fadly file nutritial constraint on the startwells. Call RETURNED         TOR.E21.TOLCS.L1.P2.CCI       RP23077       MR122       164       Fadly file nutritial constraint on the startwells. Call RETURNED         Repair ID       PP100099       Asset TOR.E21.TOLCS.L1.R1       Untilled - Note padl       Image: Mail Call Returned file nutritial constraint on the startwells. Tol. 1005         Mediate Type       Fadly file nutritial constraint on the card Address       Card Address       Image: Mail Call Returned file nutritial constraint on the card Address         Mediate Type       No ten pair       Car								Alarm fault standing.				Replaced by technician a		
TOR.E21.TOLCS.LI.P.2.CCII       RP23087       MR122       195       R2 Mux10. Intermittent fon fals alarm. MR122 nill       Call       RETURNED         TOR.E21.TOLCS.LI.P.2.CCII       RP2307       MR122       164       Fadly microsoft-to nAffals alarm. MR122 nill       Call       RETURNED         TOR.E21.TOLCS.LI.P.2.CCII       RP2307       MR122       164       Fadly microsoft-to nAffals alarm. MR122 nill       Call       RETURNED         TOR.E21.TOLCS.LI.P.2.CCII       RP2307       MR122       168       Fadly microsoft-to nAffals alarm. MR122 nill       DETIRNED         Repair ID       P       P       Repair ID       P       Repair ID       P       Repair ID       P       P       Repair ID       P       Intil Idd - Note pad       Intil Idd - Note														
Image: Second														
TOE EST TOL CE 12 DE BAVIN       BESANT       NB 122       TER Ean failed & nucles manual fluxden nucl attached tr. Call       DETLEMEN         Image: Ima									IR122 in!!					
Repair ID       RP140009       Asset       TOR.E21.TOLCS.LL.RI       Untitled - Notepad       Image: Control of														
Repair ID     RP14009     Asset     TOR.E21.TOLCS.L1.R1     Untitled - Notepad       Medule Type     MR122     Serial No.     1635       Description     Fault     Card Address     Cord Address       Fault     paddle loose, moving easily injout of position whilst fan operational causing fleeting fan fait alarm.     Card Address					1177	1875					DETIDATI			
Medde Type     MR122     Serial Ne.     1635       Description     Fan Unit     Card Address       Entra Location Info     Card Address       Description     paddle loose, moving easily in/out of position whilst fan operational causing fleeting fan fail alarm.			-											<u> </u>
Module Description         Fon Unit         Card Address           Extra Location Info Description         padde loose, moving easily in/out of position whilst fan operational causing fleeting fan fait alarm.         Card Address		Rep	air ID RP1400	89				Asset	TOR.E21.TO	LCS.L1	.R1 🖪 Untitle	d - Notepad		
Description Eastra Location Inform Eastra Location Inform Fault Description Total on Descript		Module	Type MR122					Serial No.	1635					۳.
Extra Location Info Extra Location Info Fault Fault Description Fault Description Fault Fa		Descr	odule Fan Uni	t										
Description No.								Card Address						
Test on Return No		Descr		paddle loose, moving easily in/out of position whilst fan operational causing fleeting fan fail alarm.										
		Test on F	eturn No											



# Underpinning Tools & Techniques (4) Failure Analysis



# Underpinning Tools & Techniques (5) SQEP Planning



Axis : The numerical value on the graph represents the number of people for that role.





# **Support for Change/Improvements (1)**

The DPCS system is heavily relied upon as the main operational management system. There is a constant demand for changes and improvements to support new/changed plant and/or new/changed operational procedures.

The main stakeholder groups have traditionally included:

- Operators (improvements, automation)
- Project Teams (new signals)
- Internal (improvements)

Lately, the most significant demands have been from two main stakeholder groups:

- Station Management reliability.
- Regulator computer security
- Regulator change related QA

These changes typically include BOTH hardware and/or software changes.

Although DPCS reliability & functionality have peaked, there are increasing requirements and expectations.





# Support for Changes/Improvements (2)

#### **Capability (Hardware)**

- Prioritised approach
- Use of AMS KPIs for 'best return on investment/effort'
- Element of reality i.e. PSUs are 'easy', dedicated logic chips 'hard'
- Equipment qualification can be very costly & time consuming.
- Commission Testing (practical ?).
- Maintenance change rather than replacement ?

#### **Capability (Software)**

- Several highly complex legacy issues multi year investigations
- Heavy dependence on handful of 'grey beard' personnel
- Limited resources
- Succession planning coupled with development opportunity
- Toolchain maintenance
- 'Insurance' versus 'flexibility'

**Cost versus Benefit** 





### **OPEX**

MG20 – Annual routine now established – already paid dividends!

R2 CC09 (electrolytic caps) – All L2, R2, SOCLS & LSTF addressed – R1!

<u>R1 CC01 – PF options switch incorrect – extent of condition addressed.</u>

<u>Store relay replacement</u> – based on well known OPEX and spot checks during the year. All R2 AC store relays bulk replaced during stat outage. R1 !

<u>PSU Replacement</u> – TOR OPEX (&EC substantiation/testing) shared with fleet. – Ongoing program of rollout.

<u>MR257 Replacement</u> – TOR OPEX (&EC substantiation/testing) – Ongoing program of rollout.

<u>Thermal Camera Walkdown</u> – prompted by SZB PSU issue. Several issues addressed including faulty MR172 auto changeover unit, poor PSU crimping, degraded PSU power cable (PSU replaced). Routine to be established.

**System Console Replacement – TOR OPEX (& EC substantiation/ testing) shared with fleet.** 





### **FUTURES**

### **Availability & Reliability**

Continue with AMS KPIs and failure trend analysis Complete ongoing priority fault investigations Review OPEX & amend maintenance as necessary Maintenance - 'Grey beards knowledge capture' – training & documentation

**Support for Changes/Improvements** 

Progress/complete ongoing hardware replacement programs Computer Security Improvements Continue to support stakeholder changes for DPCS integration.

### **Strategic**

Software change support – strategic view Outsourcing v Insourcing (burden of cost will fall to station in 2023) SQEP reinforcement – organisational restructuring (locally) Minimum support needed ?





# THANK YOU

