



# SN Human Error Management



# Introduction



## ❑ History

- 2007 – 29 errors; 1 error per 4,600 hours of support – worst year
- 2010 – 16 errors; 1 error per 10,500 hours of support – best year
- 2011 – 30 errors; 1 error per 5,500 hours of support – improvement required

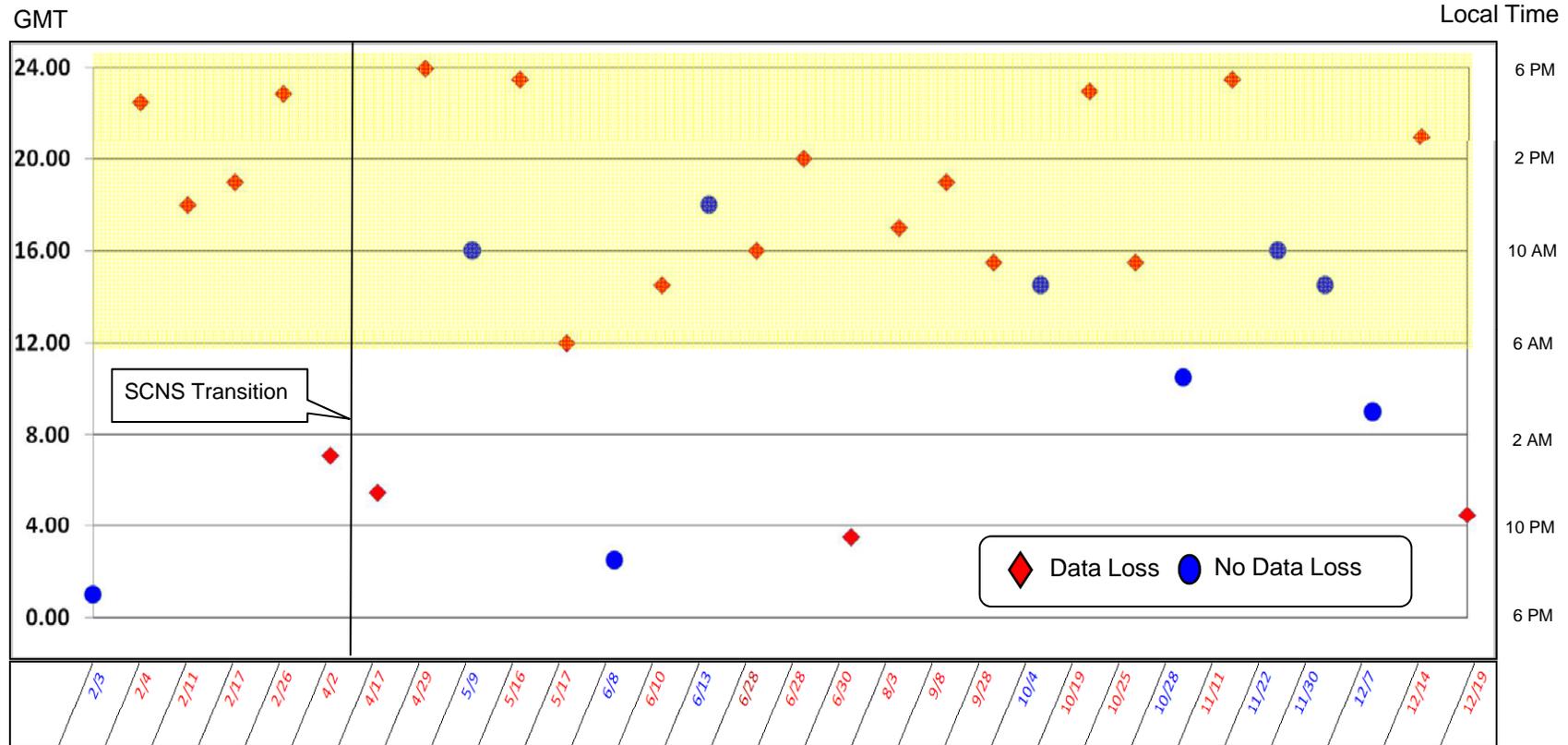
## ❑ Reviewed anomalies from the last 3 years to identify possible trends (Overtime, time of day, and activity level)

- Errors included skipped procedural steps, inattention to detail, and incorrectly verified commands.
  - ◆ Industry Best Practice and Human Performance Improvement tools applicability
- Causal factor review indicate a lack of situational awareness and training in some cases
- High level of maintenance/engineering activity is a contributor
- Complexity of TDRS-K modifications contributed to several errors
- Annual procedure review identified specific and systemic problems with procedures
- Phase one delivery of the Axiom local operating procedure tool lacks intuitive Human Machine Interface (HMI)
  - ◆ Additional enhancements are required to improve the HMI and the system operability
- **SW fixes** addressing system discrepancies are lagging due to customer needs (TDRS-K, USSCR, Ports, SIMOSKIF)
- There are 58 Alert Notice workarounds that are tied to software fixes.
  - ◆ Current CORE sustainment fixes: 24 in OPS003, 14 in OPS004, and 12 in OPS005
- WSC is working closely with NASA 452 to deliver these fixes.

SCNS is concerned about errors and is implementing process improvements to minimize risk to the SN



# Relationship of Errors & Time of Day

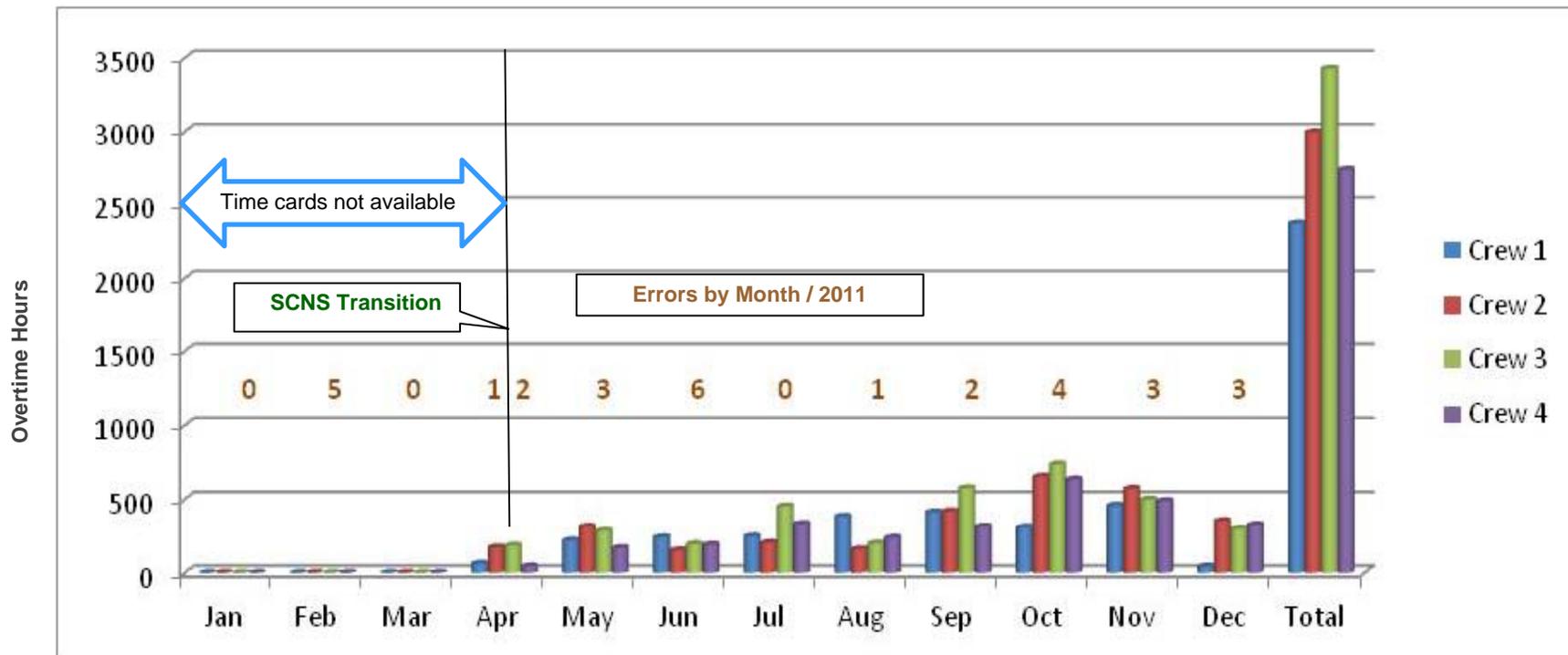


Note: this chart reflects all WSC 2011 errors.

**Most errors occurred during dayshift hours where the heaviest activities occurred.**



# Relationship Of Errors & Overtime



- Due to TDRS-K training requirements, controllers averaged 60 hour work weeks from Sept – Nov,
  - Comparing the periods of Apr – Jun vs. Sep – Nov the data suggests overtime was not a factor

WSC will continue to manage overtime so it does not become a factor.



# Recent Improvements



- ❑ **Actions taken to ensure successful launch supports**
  - Implemented senior management oversight
  - Conduct WSC Internal Readiness Review (IRR) for each launch similar to STS missions
  - Conduct pre-launch verification/validation testing for all launch supports
  - Conduct pre-launch briefing with the launch support team
  - Trained and certified 4 Vector Controllers
  - WSC staff now includes a Launch Engineer, Software Engineer, Hardware Engineer, and S/C Engineer
  - Perform post mission debrief or “Hot Wash”
  - WSC Launch Proficiency is 100% for the last 11 launches since process improvement implementation
- ❑ **Developed more reliable solution to high risk LPA configuration during ELV launches**
- ❑ **Site Manager conducted skip level meetings with Ops crews**
  - These meeting will be held annually for all WSC employees
- ❑ **WSC Senior management held OS and crew meetings**
  - Discussed concerns and conveyed expectations
- ❑ **Voice Protocol and Voice system enhancements**
  - Mandated Headset use
  - All customers moved to voice system vs. LSAT-5 and LDBP(balloon) on black phone
  - Integrating industry best practice 3-Way communication for verification process

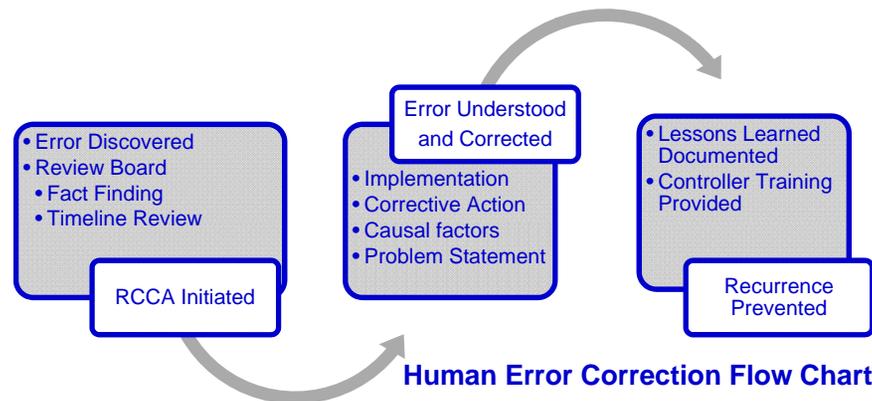
**WSC is continuously improving processes and communication.**



## Recent Improvements (Continued)



- ❑ **Ops initiated an incident review immediately following an error**
  - Gather facts, populate and review RCCA, and assess risk to the SN
  - Site management and crew members involved
  - Results in a accurate recall of events and timeline development
- ❑ **Conducting a weekly RCCA review for possible trends and lessons learned**
  - Conducting lessons learned review with crews



- ❑ **Streamlined LOP review and updates**
  - Installed Axiom on the Ops Supervisor PC making it available for the crews to develop tailored procedures
  - Enabled electronic access to LOP soft copies for Operations personnel
  - Completed annual review of operations LOPs in January 2012



# Near Term Process Improvement Steps



- ❑ **Engage SN Externals to review common practices for reducing errors**
- ❑ **Review and make recommendations for an improved crew rotation schedule**
- ❑ **Provide Operations Supervisors with leadership training**
- ❑ **Perform risk assessment on scheduled activities**
  - Balance activities throughout the schedule to minimize concurrent activities
  - Increase staff during high activity periods
- ❑ **Perform risk assessment on staffing roles and responsibilities**
  - Assessing requirements for Test Conductor and Operations tools development positions
- ❑ **Develop consistency between crews**
  - Team charter developed and team is meeting weekly.
- ❑ **Develop and implement a new Fagan style LOP inspection/audit process**
  - Team charter developed and team is meeting weekly.
- ❑ **Develop and implement HU performance tools**
  - Develop human performance error mitigation tools from the Error Prone Tasks list
  - Review Industry Best Practices and available tools
  - Tools will move WSC towards World Class Status



# Long Range Process Improvement Plans



- ❑ **Improve Situational Awareness**
  - E-LOP infrastructure.
  - Large monitor displays with rolling schedule
  - STK modeling to allow graphic representation for simulations and maneuvers
  - Automation (MicroStrategy) for gathering metrics data
    - ◆ OS can focus on managing the day to day operation
- ❑ **Leverage recent control center visits to make TOCC improvements**
- ❑ **Implement operations training process improvements**
  - Utilize SMTF simulator training for annual re-certification
  - Table top exercises for anomaly recovery, contingency, and task intensive – time critical activities
    - ◆ Simulator and table top training will require ~ 72 additional hours OT per month
- ❑ **Develop PC based program tracking to point ground and TDRS SGL antenna during SW deliveries**
- ❑ **Site Management has requested System Engineering to evaluate O&M processes.**
- ❑ **Share lessons learned with SCaN to improve overall performance of NASA networks**



## Long Range (Cont)



- 911 call center example shows glass dividers.
- Operations intent is to utilize dividers to direct traffic away from and limit access to controller areas while reducing noise.
- Console glass will aid in three way communication – Voice loop use



# At Risk Practices



What do we do routinely that put the SN and Operators at risk for an error?

## □ Identify and Define WSC At Risk Practices And Communicate These To The Crews

- At Risk Practices are Predictable, Manageable, and Preventable. Some industry examples are:
  - Note: Items in **Red** are examples of issues noted in 2011 operator errors.
    - ◆ **Not understanding the intent of a procedure step before performing it**
    - ◆ **Self-checking without referencing the LOP**
    - ◆ **Performing several manual actions in rapid succession**
    - ◆ **Performing the action when uncertainties or discrepancies exist**
    - ◆ **Performing the action while distracted by non-related concurrent activities**
    - ◆ Looking at something other than the component being manipulated
    - ◆ Not self-checking again after losing visual or physical contact
    - ◆ **Not identifying critical steps and activities in advance**
    - ◆ Not taking the time to verify that results are correct
    - ◆ **Being tired, sleepy, or fatigued**
- WSC At Risk Procedures - Actions:
  - ◆ Handovers, Antenna Switchovers, Manual GCMR Actions, Software Deliveries or losses of ADPE control, Walk-on activities, Exercising alert notices or TSI procedures, Launches, Recovery from Maintenance activities, ADPE DB Xfer, bottle plug reconfiguration, DAS/EMC reconfiguration, Patch panel actions, MMI operations for manual switch connections, Door interlock, correct component identification, manual chain failover, demand maintenance on live chain, any EC implementation



# Human Performance Tools



# Process Improvements

## Human Performance Tools



- **Initiated research into industry best practices for developing and implementing human performance tools**
  - Tools modeled from International Atomic Energy Agency (IAEA) and Department of Energy (DOE)
  - Provided best practice HU Performance Tools video to the Ops crews
    - HU is the industry standard for the human element
    - Controllers are responding with positive feedback
    - Better understanding of how tools apply
  
- **Developed “Error Prone Task” list**
  - Handovers, Antenna Switchovers, Software Deliveries , etc
  - Provides justification for augmented staffing
  - Provides areas for future system improvement including SGSS



**Suggested mouse pad/poster  
for an “attention getter”.**



# Hu TOOLS



## □ 14 New Tools being developed for use at WSC

➤ Roll Out Training Scheduled For O&M May 14 – 18th

<b>Pre Job Briefing</b> <b>S-A-F-E-R</b> Summarize Critical steps Anticipate Error likely situation Foresee consequences Evaluate barriers/defenses Review past experiences – errors	<b>Touch S-T-A-R</b> Stop Think Act Review
<b>Two Minute Rule</b>	<b>Independent Verification</b>
<b>Three Way Communication</b>	<b>Concurrent Verification</b>
<b>Phonetic Alphabet</b>	<b>Peer Check – Somewhat like the WSC 2 person verification</b>
<b>Procedure Use &amp; Adherence</b>	<b>First Check</b>
<b>Place Keeping</b>	<b>STOP When Unsure</b>
<b>Flagging / Operational Barriers</b>	<b>Post Job Review</b>



# Error Categories



- ❑ **WSC is working on the definition of and categorization of errors**
  - E1 – Disregard for procedure or policy – skipped step
  - E2 – Poor procedure or policy – poorly written step
  - E3 – Failed device or SW with established workaround – workaround not followed
  - E4 – Heat of the battle – actions taken to correct a time critical anomaly
- ❑ **Excerpts from a white paper showing different categories of errors.**
  - **Skill-Based Errors:** Errors which occur in the operator's execution of a routine, highly practiced task relating to procedure, training or proficiency and result in an unsafe a situation (e.g., fail to prioritize attention, checklist error, negative habit).
  - **Decision Errors:** Errors which occur when the behaviors or actions of the operators proceed as intended yet the chosen plan proves inadequate to achieve the desired end-state and results in an unsafe situation (e.g, exceeded ability, rule-based error, inappropriate procedure).
  - **Perceptual Errors:** Errors which occur when an operator's sensory input is degraded and a decision is made based upon faulty information.
  - **Technological Environment:** Refers to factors that include a variety of design and automation issues including the design of equipment and controls, display/interface characteristics, checklist layouts, task factors and automation.
  - **Crew Resource Management:** Refers to factors that include communication, coordination, planning, and teamwork issues.
  - **Personal Readiness:** Refers to off-duty activities required to perform optimally on the job such as adhering to crew rest requirements, alcohol restrictions, and other off-duty mandates.



## Useful Documents



- ❑ **HUMAN PERFORMANCE IMPROVEMENT IN ORGANIZATIONS: POTENTIAL APPLICATION FOR THE NUCLEAR INDUSTRY, IAEA, VIENNA, 2005; IAEA-TECDOC-1479; ISBN 92-0-111505-9; ISSN 1011-4289**
- ❑ **European Organization For The Safety Of Air Navigation The Human Error in ATM Technique (HERA-JANUS) 21.02.2003**
- ❑ **Human Performance Improvement Implementation at the Idaho National Laboratory: Milestones, Successes and Lessons Learned; Dr. Bob Richards and Joy Rule, Center for Human Performance Improvement, August 2007**
- ❑ **The Human Factors Analysis and Classification System (HFACS) developed by Dr Scott Shappell and Dr Doug Wiegmann, Civil Aviation Medical Institute and University of Illinois at Urbana-Campaign, USA**
- ❑ **Department of Energy Human Performance Handbook HUMAN PERFORMANCE IMPROVEMENT CONCEPTS AND PRINCIPLES Dated November 2007**
- ❑ **Nebraska Power , Cooper Nuclear power station, CNS OPERATIONS MANUAL QUALITY: NON-QAPD, ADMINISTRATIVE PROCEDURE 0-HU-TOOLS EFFECTIVE: 9/21/10 REVISION 17**
- ❑ **Tennessee Valley Authority Human Performance Tool presentation – The Human Performance Tool Box (no version or reference date provided)**
- ❑ **Tennessee Valley Authority Human Performance video titled: HU\_TOOLS**
- ❑ **The Federal Aviation Administration is giving the green light for American Airlines pilots to use iPads in the cockpit instead of traditional paper flight manuals, [\*The New York Times\*](#) reports.**



## Backup



# Shift Work Study



- ❑ **Reader Poll from Cashmoneylife Web magazine: Which Shift to You Prefer to Work?**
  - Days: 8-4 (49%, 221 Votes)
  - Swings: 4-12 (18%, 80 Votes)
  - I'm just thankful to have a job (14%, 62 Votes)
  - Mids: 12-8 (10%, 47 Votes)
  - Twelves: 12 hour shifts (9%, 41 Votes)
- ❑ **American College of Emergency Physicians**
  - The adverse effect of constantly rotating shifts is the single most important reason given for premature attrition from the field.
  - There are many biological and social problems associated with rotating shifts. Physical problems include an incidence of peptic ulcer disease eight times that of the normal population. Cardiovascular mortality has also been noted to be increased among shift workers.
- ❑ **All of the recent major disasters attributed to human error** (Exxon Valdez oil spill, Three Mile Island, Bophal chemical plant explosion, Chernobyl), occurred on the night shift.
- ❑ **Takeaway: Shift work is a fact of life but rotating shifts should be avoided.**



# HU Improvements Schedule



ID	Task Name	Start	Finish	% Complete	1st Quarter			2nd Quarter			3rd Quarter			4th Quarter			1st Quarter			2nd Quarter			3rd Quarter					
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	Human Error Mitigation Plan as on	1/16/12	7/1/13	0%	[Progress bar]																							
2					[Progress bar]																							
3	<b>LOP Improvements</b>	<b>1/12/12</b>	<b>10/1/12</b>	<b>55%</b>	[Progress bar]																							
7					[Progress bar]																							
8	<b>Human Performance Tools</b>	<b>Fri 1/6/12</b>	<b>5/29/15</b>	<b>3%</b>	[Progress bar]																							
9	Complete Error Prone Task L	Fri 1/6/12	J 3/29/12	50%	[Progress bar]																							
10	Apply HU Tools to error prori	3/30/12	ri 4/3/15	0%	[Progress bar]																							
11	<b>Rollout Tools &amp; Training</b>	<b>Fri 5/1/15</b>	<b>5/29/15</b>	<b>0%</b>	[Progress bar]																							
12	Joint classes w ith Ops/G	Fri 5/1/15	i 5/29/15	0%	[Progress bar]																							
13	<b>TOCC Infrastructure Improv</b>	<b>Fri 1/6/12</b>	<b>2/28/12</b>	<b>10%</b>	[Progress bar]																							
14	Console Sw ap OS/VC	e 2/28/12	s 2/28/12	10%	[Progress bar]																							
15	<b>Sound proofing &amp; Traffic</b>	<b>Fri 1/6/12</b>	<b>ri 1/6/12</b>	<b>10%</b>	[Progress bar]																							
16	Console Glass - Plexiglas	Fri 1/6/12	ri 1/6/12	10%	[Progress bar]																							
17	Interior Walls - Dividers	Fri 1/6/12	ri 1/6/12	10%	[Progress bar]																							
18					[Progress bar]																							
19	<b>Crew Rotation Schedule Re</b>	<b>Fri 1/6/12</b>	<b>n 3/5/12</b>	<b>77%</b>	[Progress bar]																							
20	Crew Survey	d 2/29/12	n 3/5/12	100%	[Progress bar]																							
21	MS/IS Work Week discussio	Fri 1/6/12	ri 1/6/12	100%	[Progress bar]																							
22	Development and roll out of	Fri 1/6/12	ri 1/6/12	10%	[Progress bar]																							
23	Staffing Roles and Respons	Fri 1/6/12	ri 1/6/12	30%	[Progress bar]																							
24					[Progress bar]																							
25	<b>Engage JSC and DSN to revie</b>	<b>d 2/8/12</b>	<b>i 4/20/12</b>	<b>2%</b>	[Progress bar]																							
26	<b>JSC Discussions</b>	<b>ri 3/16/12</b>	<b>i 4/20/12</b>	<b>17%</b>	[Progress bar]																							
27	GC Visit WSC Open disc	ri 3/16/12	i 3/16/12	100%	[Progress bar]																							
28	WSC Visit JSC Open Dis	n 4/16/12	i 4/20/12	0%	[Progress bar]																							
29	DSN Discussions	ed 2/8/12	i 3/30/12	0%	[Progress bar]																							
30					[Progress bar]																							
31	<b>Operations Supervisors Le</b>	<b>hu 2/2/12</b>	<b>ie 5/1/12</b>	<b>99%</b>	[Progress bar]																							
32	Enroll OS in Ledership Train	id 2/29/12	ri 3/9/12	100%	[Progress bar]																							
33	<b>Crew 1</b>	<b>ri 2/10/12</b>	<b>i 4/18/12</b>	<b>99%</b>	[Progress bar]																							
37	<b>Crew 2</b>	<b>hu 2/2/12</b>	<b>i 4/18/12</b>	<b>99%</b>	[Progress bar]																							
41	<b>Crew 3</b>	<b>hu 2/2/12</b>	<b>ie 5/1/12</b>	<b>100%</b>	[Progress bar]																							
45	<b>Crew 4</b>	<b>hu 2/2/12</b>	<b>i 4/18/12</b>	<b>99%</b>	[Progress bar]																							
49					[Progress bar]																							
50	<b>Develop Consistency Betw</b>	<b>e Fri 1/6/12</b>	<b>5/30/13</b>	<b>50%</b>	[Progress bar]																							
51	<b>Develop Team Charter</b>	<b>Fri 1/6/12</b>	<b>5/30/13</b>	<b>50%</b>	[Progress bar]																							
52	Communications	Fri 1/6/12	J 5/30/13	50%	[Progress bar]																							
53	Training	Fri 1/6/12	J 5/30/13	50%	[Progress bar]																							
54	Performance	Fri 1/6/12	J 5/30/13	50%	[Progress bar]																							
55	Staffing	Fri 1/6/12	J 5/30/13	50%	[Progress bar]																							
56					[Progress bar]																							
57	<b>Im plement Ops Training Pr</b>	<b>ri 2/10/12</b>	<b>i 5/31/12</b>	<b>13%</b>	[Progress bar]																							
58	Sim Training for SATCONs	-ri 2/10/12	J 2/23/12	100%	[Progress bar]																							
59	Develop Table Top Training In	2/27/12	J 5/31/12	0%	[Progress bar]																							