

# Situated Information Search & Access for Space Station & Shuttle Mission Operations Personnel

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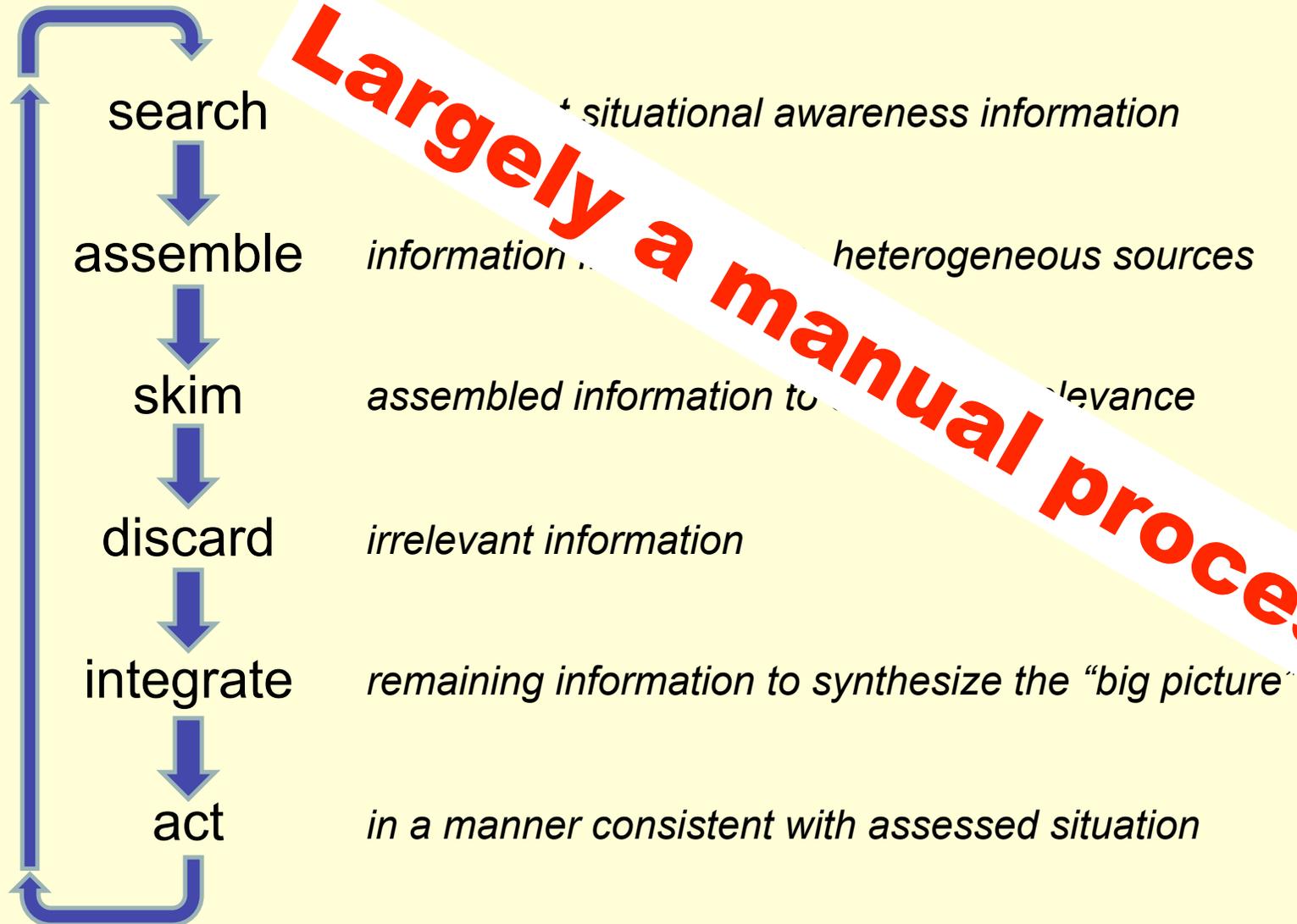


# Situation Awareness for Mission Operations

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- **Situation awareness** (both current and historical) is critical to mission operations
  - Current awareness:  
Real-time telemetry and communication feeds provide the basis for *current* situation awareness
  - Historical awareness:  
Mission documents, reports, logs, data provide the basis for *historical* situation awareness
- **Effective decision-making** depends on an accurate knowledge of the current operating situation and historical precedents
- **Information retrieval** is an essential component of the decision-making process

# Flight Controller's Information Retrieval Process



**Largely a manual process**

# NASA Mission Control

Flight Control Operations Handbook (FCOH) Station Operations

Space Shuttle Operational Flight Rules

Volume A

All Flights

Mission Operations Directorate

GENERAL AUTHORITY AND DEFINITIONS	1
FLIGHT OPERATIONS	2
GROUND INSTRUMENTATION	3
TRAJECTORY AND GUIDANCE	4
BOOSTER	5
PROPULSION	6
DATA SYSTEMS	7
SUBSTANCE HANDLING AND CONTROL (SHAC)	8
ELECTRICAL	9
MECHANICAL	10
COMMUNICATIONS	11
ROBOTICS	12

ChITS Mission Act System

CONTROL #	REQ	ORG	SUBJECT	STATE	GMT CREATED
005204	MOD		Request EVA 3 updated video playback times from EV1 Mastracchio WVS	PRELIMINARY	2007/228-05-04 20
005203	IMC		13A-1 Transfer (US): SH8 FD10	OPEN	2007/228-04-30 20
005202	IMC		13A-1 Transfer (US): Middeck FD10	OPEN	2007/228-04-29 20
005201	MOD		Attitude Control Constraints for Tile Repair	WITHDRAWN	2007/228-04-12 04
005200	ISSMER		Request for Additional Photos of Prime EMU Gloves	OPEN	2007/228-01-31 02
005199	MOD		Tile Repair EVA Support	OPEN	2007/228-01-16 20
005198	IMC		Stowage of EVA tools in Port T5A for TPS repair EVA	PRELIMINARY	2007/227-20-01 20
005197	ISSMER		Notification #1 of Recently Created SPVs Affecting 13A-1 Stage	PRELIMINARY	2007/227-19-20 20
005196	ISSMER		EVA EMU & Equipment Assessment for Orbiter Tile Repair	PRELIMINARY	2007/227-19-02 20
005195	MOD		FC Purge Limits	CLOSED	2007/227-12-23 20
005194	IPRUSIA		ESA MPEQ-2 coder test	PRELIMINARY	2007/227-11-35 20
005193	IMC		13A-1 Transfer (US): SH8 FD09	CLOSED	2007/227-06-10 20
005192	IMC		13A-1 Transfer (US): Middeck FD09	CLOSED	2007/227-04-08 20
005191	ISSMER		Assessment of EVA Hazards Associated with Repair of Damaged Tile on 118/13A-1 [DO NOT OPEN]	PRELIMINARY	2007/227-04-29 20
005190	ISSMER		ISS CDM and battery use request (revised)	PRELIMINARY	2007/227-04-29 20

DISCIPLINE SUBJECT

002642	MMACS	H10 3 RSUR CITY Desc
002641	MMACS	Window #2 Thermal
002640	SURGEON	EVCPDS 2 & 3 Lockup
002639	EVA	EVA: APPF7 Soft Lock
002638	EVA	SASA Soft Dock Release
002637	CATO	S-band String 2 Adapter
002636	EVA	BSP Dummy Box High
002635	PROP	LOMS GN2 Pressure
002634	EVA	EMU glove TMG Damage
002633	ECLSS	Erratic CDRA ADDES
002632	SURGEON	EVCPDS 2 & 3 Lockup
002631	CATO	Auto-CRM rejected test
002630	ROBO	MT Translation WS74
002629	EVA	EVA BSA Error Message
002628	CATO	Flight Rule Waiver, B
002627	ROBO	Sticky Release of Lab

PPCR Planning Product Change Request

PPCR #	TITLE
15-1299	Roll-up Changes to FD10
15-1249	RS Changes to FD 13 (GMT 232)
15-1248	FD10 Changes due to EVA 4 Replanning
15-1247	August Network Work Plan / ISS IMPACTS REV B
15-1246	RS Changes to FD11
15-1245	RS Changes to FD10
15-1244	RS Changes to FD9
15-1243B	Roll-up Changes to FD9
15-1243	RS Changes to FD12
15-1241	RS Changes to FD 8
15-1240	Extension of 13A-1 Docked Mission
15-1239	RS Changes to FD10
15-1238B	Roll-up Changes to FD8
15-1237	RS Changes to FD7
15-1236	RS Changes to FD6

Original November 30, 2000

DCN-006  
October 10, 2003  
and subsequent  
Real-Time releases with  
last release on 07/30/07

## Current Practice

Every flight controller must access thousands of pieces of info spread over numerous data bases, documents, spreadsheets, emails, web sites, etc

OSTPV Onboard Site Plan View

ISS CDR: ACH-MH-F-21P-CI-XFEA, EXERCISE-TV, MIDDAY-MEAL

FE-1: EXERCISE-REL, PFM/B, PFM/BP-E, JMS, MIDDAY-MEAL, HM

S-BD: EXERCISE-REL, PFM/B, PFM/BP-E, JMS, MIDDAY-MEAL, HM

System List:

- US\_PODF
- US\_SODF
- 13A Assey Ops
- C&D/H - Command and Data Handling
- C&T Communications and Tracking
- Crew Handover
- Crew Handover E14 - E15
- CSS - Crew Support Book
- ECLSS - Environmental Control and Life Support System
- EPS - Electrical Power System
- EVA - Extra Vehicular Activities
- IFM - In Flight Maintenance
- Joint Operations
- MCS - Motion Control System
- Med C/L - Medical Checklist
- Med Ops - Medical Operations
- MPLM - Multi-Purpose Logistics Module
- POC - Portable Onboard Computers
- ISS TVT
- Robotics
- Robotics Flight Specific - 13A1
- Nominal
- S5
- ORBS



International Proc

Version 2

# What's wrong with the current information infrastructure?

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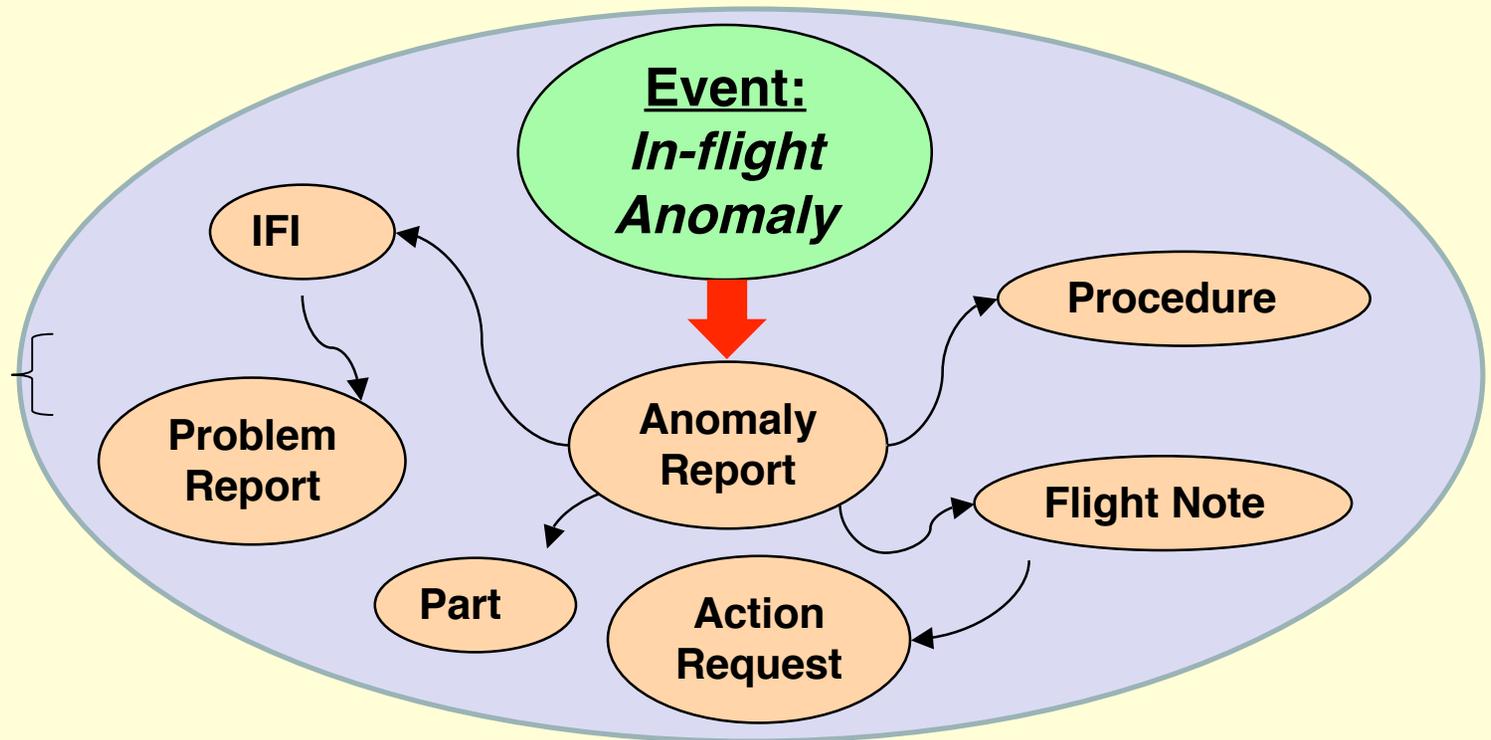
- ❑ Information access is *document*-centric, not *situation*-centric (i.e., event-, issue-, or activity-centric)
- ❑ After an situation occurs, no breadcrumb trail remains to tie information together
- ❑ Situation-relevant information is fragmented across many different sources
- ❑ Interrelationships between information are not captured

**Information Lacks Context!**

# Information Context

**Context encompasses all operationally-relevant information connected with a given event/issue**

*Information associated with an operational event/issue*



**Just the tip of the iceberg!**

# Search Tools for Mission Operations

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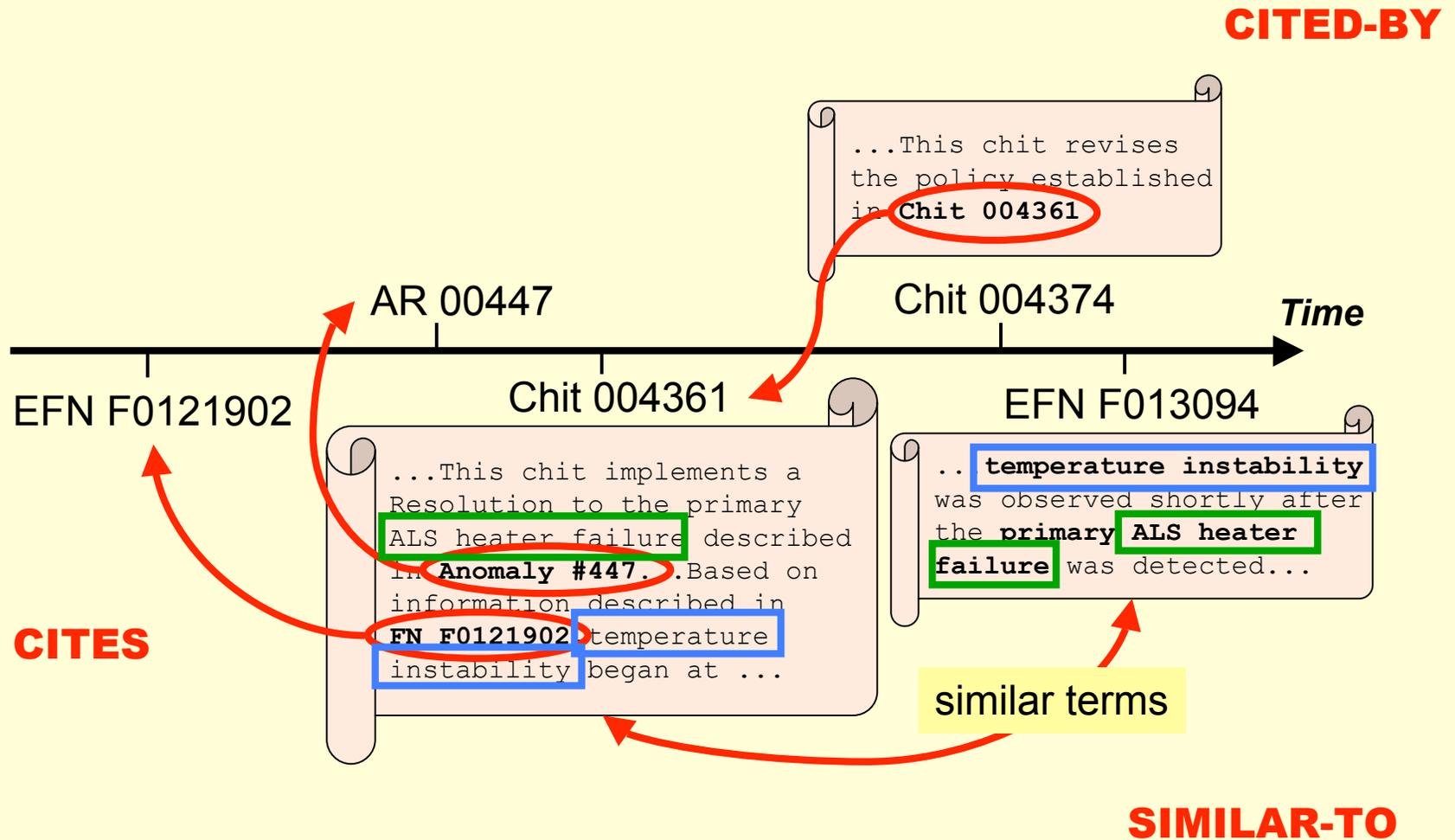
- **Purpose:**
  - Improve Flight Controller situational awareness:
    - Enhance Flight Controller access to widely dispersed operations info
    - Situate information presented in relation to other relevant information
- **Approach:**
  - Integrate Search
    - Search across multiple information sources simultaneously
      - *Flight control resources, engineering resources, other data resources*
    - Search across heterogeneously formatted information
      - *Databases, documents, web sites*
  - Improve Search
    - Modern full-text search (vs. title-only search)
    - Query expansion using synonyms/acronyms/taxonomies
  - Contextualize Search
    - Situate search results by recovering web of interrelationships
    - Enable issue/activity/event-centered search vs. document-centered search

# Context Recovery

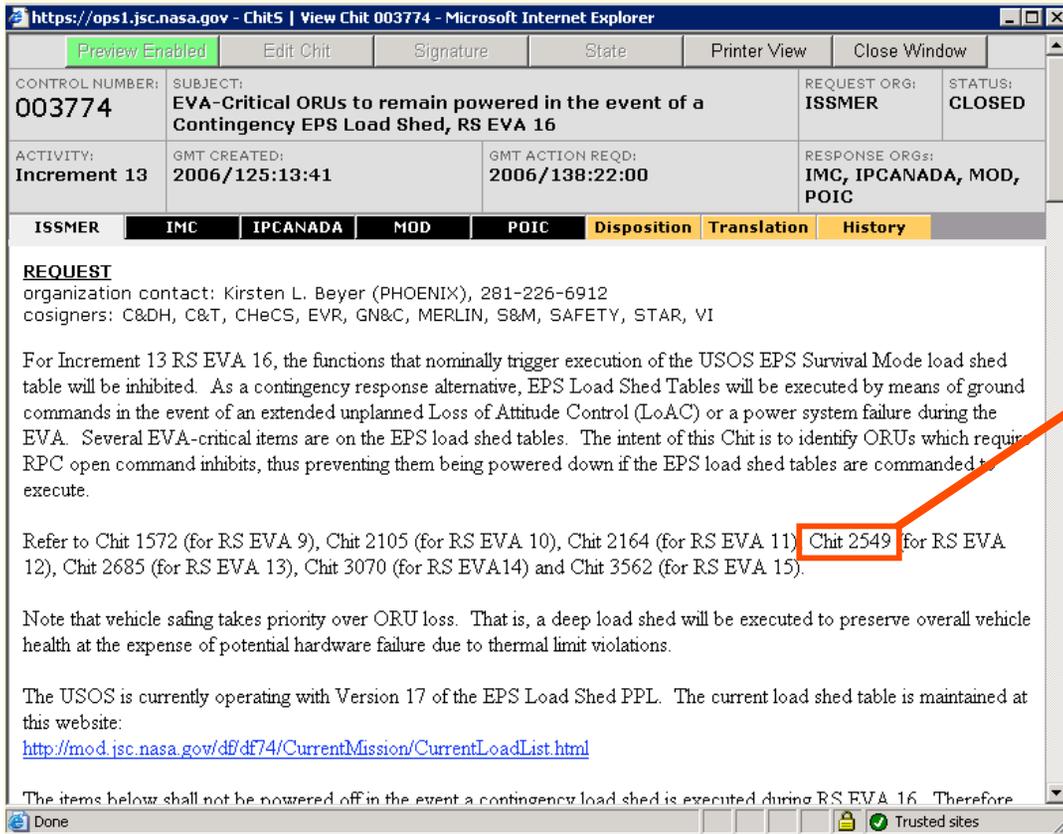
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- Recover relationships among information:
  1. Analyze document text for explicit references to other documents, events, activities, or issues
  2. Perform inter-document similarity analysis to determine implicit relationships among documents

# Context Recovery Illustration



# Actual Cross-referencing in Chits/FNs/ARs



https://ops1.jsc.nasa.gov - Chit5 | View Chit 003774 - Microsoft Internet Explorer

CONTROL NUMBER: <b>003774</b>	SUBJECT: <b>EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 16</b>	REQUEST ORG: <b>ISSMER</b>	STATUS: <b>CLOSED</b>
ACTIVITY: <b>Increment 13</b>	GMT CREATED: <b>2006/125:13:41</b>	GMT ACTION REQD: <b>2006/138:22:00</b>	RESPONSE ORGS: <b>IMC, IPCANADA, MOD, POIC</b>

ISSMER IMC IPCANADA MOD POIC **Disposition** Translation History

**REQUEST**  
organization contact: Kirsten L. Beyer (PHOENIX), 281-226-6912  
cosigners: C&DH, C&T, CheCS, EVR, GN&C, MERLIN, S&M, SAFETY, STAR, VI

For Increment 13 RS EVA 16, the functions that nominally trigger execution of the USOS EPS Survival Mode load shed table will be inhibited. As a contingency response alternative, EPS Load Shed Tables will be executed by means of ground commands in the event of an extended unplanned Loss of Attitude Control (LoAC) or a power system failure during the EVA. Several EVA-critical items are on the EPS load shed tables. The intent of this Chit is to identify ORUs which require RPC open command inhibits, thus preventing them being powered down if the EPS load shed tables are commanded to execute.

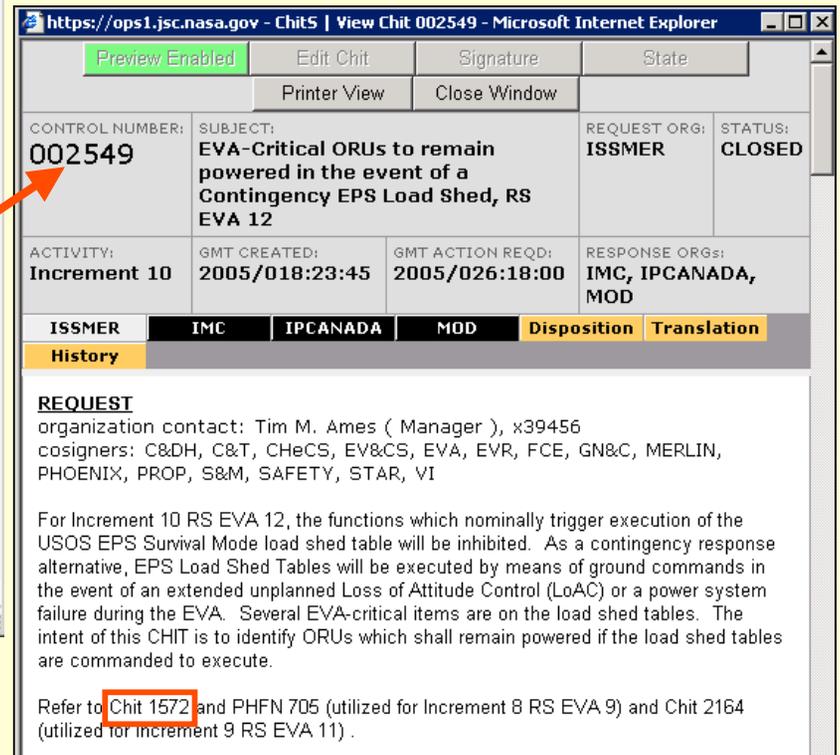
Refer to Chit 1572 (for RS EVA 9), Chit 2105 (for RS EVA 10), Chit 2164 (for RS EVA 11), **Chit 2549** for RS EVA 12), Chit 2685 (for RS EVA 13), Chit 3070 (for RS EVA14) and Chit 3562 (for RS EVA 15).

Note that vehicle safing takes priority over ORU loss. That is, a deep load shed will be executed to preserve overall vehicle health at the expense of potential hardware failure due to thermal limit violations.

The USOS is currently operating with Version 17 of the EPS Load Shed PPL. The current load shed table is maintained at this website:  
<http://mod.jsc.nasa.gov/db/df74/CurrentMission/CurrentLoadList.html>

The items below shall not be powered off in the event a contingency load shed is executed during RS EVA 16. Therefore

*Also part #, s/n references*



https://ops1.jsc.nasa.gov - Chit5 | View Chit 002549 - Microsoft Internet Explorer

CONTROL NUMBER: <b>002549</b>	SUBJECT: <b>EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 12</b>	REQUEST ORG: <b>ISSMER</b>	STATUS: <b>CLOSED</b>
ACTIVITY: <b>Increment 10</b>	GMT CREATED: <b>2005/018:23:45</b>	GMT ACTION REQD: <b>2005/026:18:00</b>	RESPONSE ORGS: <b>IMC, IPCANADA, MOD</b>

ISSMER IMC IPCANADA MOD **Disposition** Translation History

**REQUEST**  
organization contact: Tim M. Ames ( Manager ), x39456  
cosigners: C&DH, C&T, CheCS, EV&CS, EVA, EVR, FCE, GN&C, MERLIN, PHOENIX, PROP, S&M, SAFETY, STAR, VI

For Increment 10 RS EVA 12, the functions which nominally trigger execution of the USOS EPS Survival Mode load shed table will be inhibited. As a contingency response alternative, EPS Load Shed Tables will be executed by means of ground commands in the event of an extended unplanned Loss of Attitude Control (LoAC) or a power system failure during the EVA. Several EVA-critical items are on the load shed tables. The intent of this CHIT is to identify ORUs which shall remain powered if the load shed tables are commanded to execute.

Refer to **Chit 1572** and PHFN 705 (utilized for Increment 8 RS EVA 9) and Chit 2164 (utilized for increment 9 RS EVA 11) .

## Opportunities:

- Hyperlinking
- Navigation and search

# XSearch System: Search Results Page

http://xsearch.arc.nasa.gov - XSearch - Microsoft Internet Explorer

Search: "EPS load shed" [Search]

Tool: Anomalies  Chits  EFN  Help

Field: Control#  Title  Text  Vehicle: ISS  STS  ?

Activity: - ALL - State: - ALL - Org: - ALL - Dspln: - ALL - Originator: - ALL - Time Period: - ALL - Items/Page: 25

XRef	Type	Control #	Req Org	Title	State	GMT Created
	Chit	<a href="#">004842</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 18 & 19	CLOSED	2007/134:15:45
	Chit	<a href="#">004649</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 17A	CLOSED	2007/045:17:02
	Chit	<a href="#">004313</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 17	CLOSED	2006/310:15:20
	EFN	<a href="#">F012902</a>	MOD-PHALCON	12A EPS Load Shed Table PPL files for uplink	Approved	2006/262:18:49
	EFN	<a href="#">F012899</a>	MOD-PHALCON	12A EPS Load Shed Table PPL files for uplink	Info_Only	2006/262:18:35
	Chit	<a href="#">003774</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 16	CLOSED	2006/125:13:41
	Chit	<a href="#">003562</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 15	CLOSED	2006/010:21:52
	EFN	<a href="#">F006964</a>	MOD-PHALCON	PHALCON updates to the EPS Load Shed List - GMT 211	Info_Only	2005/211:23:48
	Chit	<a href="#">003070</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 14	CLOSED	2005/202:19:35
	EFN	<a href="#">F0050500</a>	ISSMER-Message	12A EPS Load Shed Table PPL files for uplink	Info_Only	2005/151:17:30



**C: Cites**  
**B: Cited By**  
**S: Similar To**

# XSearch System: Cross Reference Page

## Cross References for Chit # 003774

[Back](#)

Type	Control #	Req Org	Title	State	GMT Created
Chit	<a href="#">003774</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 16	CLOSED	2006/125:13:41

[Cites](#)
[Cited By](#)
[Similar To](#)

Type	Control #	Req Org	Title	State	GMT Created	# Citations
Chit	<a href="#">003563</a>	ISSMER-VI	Failure Scenarios and Time-to-limit for Transitioning to Contingency Maneuver for MT Thermal Protection	CLOSED	2006/011:15:49	1
Chit	<a href="#">003562</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 15	CLOSED	2006/010:21:52	1
Chit	<a href="#">003533</a>	ISSMER-PHOENIX	RPCM S03A-E RPC 18 Trip Troubleshooting Tasks	CLOSED	2005/350:21:03	2
Chit	<a href="#">003070</a>	ISSMER-	EVA-Critical ORUs to remain powered in the event of a Contingency EPS	CLOSED	2005/202:19:35	1

[Cites](#)
[Cited By](#)
[Similar To](#)

Type	Control #	Req Org	Title	State	GMT Created	# Citations
Chit	<a href="#">004842</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 18 & 19	CLOSED	2007/134:15:45	1
Chit	<a href="#">004649</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 17A	CLOSED	2007/045:17:02	1
...	.....	ISSMER-	EVA-Critical ORUs to remain powered in the event of a Contingency EPS	.....	.....	..

[Cites](#)
[Cited By](#)
[Similar To](#)

Type	Control #	Req Org	Title	State	GMT Created	Score
Chit	<a href="#">003562</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 15	CLOSED	2006/010:21:52	0.98
Chit	<a href="#">004313</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 17	CLOSED	2006/310:15:20	0.93
Chit	<a href="#">004649</a>	ISSMER-PHOENIX	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load Shed, RS EVA 17A	CLOSED	2007/045:17:02	0.92
Chit	<a href="#">003070</a>	ISSMER-	EVA-Critical ORUs to remain powered in the event of a Contingency EPS Load	CLOSED	2005/202:19:35	0.81

# Cross-reference Tabs Displaying PRACAs, IFIs, and Parts

XSearch - Windows Internet Explorer

Cross References for AR # 001666 Back

Type	Control #	Req Org	Title	State	GMT Created
AR	<a href="#">001666</a>	MOD-ROBO	Loss of Multiple UMA Mated Microswitches	CLOSED	2006/192:00:55

Cites Cited By Similar To **PRACAs** IFIs

Type	#	Org.	Title	Status	Last Updated	# Citations
PRACA	<a href="#">3387</a>	ISS-MER	MT UMA 2 "Mated" Switch Annunciation Loss	O	11/28/2007 12:00:00 AM	1

1

Cites Cited By Similar To PRACAs **IFIs**

Type	Number	Class	Title	Status	GMT Created	# Citations
IFI	<a href="#">1159</a>	MER Anomaly	UMA micro switch did not annunciate	Closed	7/15/2003 3:00:00 PM	1

1

**Parts**

Type	S/N	P/N	Ops Nom (English)	Location	Label	# Citations
part	<a href="#">6006</a>	SEG39129263-301	CABLE ASSEMBLY - PCS/DC POWER (20VDC) PCS/PGSC	удален_19P		1
part	<a href="#">6017</a>	SEG39129263-301	FDC Power Supply Adapter Cable 10'	удален_19P		1
part	<a href="#">6018</a>	SEG39129263-301	FDC Power Supply Adapter Cable 10'	ISS Deployed		1
part	<a href="#">6019</a>	SEG39129263-301	FDC Power Supply Adapter Cable 10'	LOST US ITEMS		1

# Flight Note Containing Part # Cross-references

efn N009803

Close

## Title: Revision to Thursday Stowage Note

Due to the EVA Tool Restow activity today there were changes in the following procedure call outs:

### EMU-BATT DSCHRG-INIT

#### 12-0025 1.615 EMU BATTERY DISCHARGE USING SSC IN DOS MODE

1. PGSC, 760XD COMPUTER (P/N SDZ39129262-301, S/N 6016, B/C 00000452M) - A/L101 (M-02 Bag: EVA PREP AND OPS, S/N 1038, B/C 003019J)
2. BCM-PCS Interface Cable (P/N SEG33112927-301, S/N 1002, B/C 00012394J) - NOD1 (SPCE Maintenance Ziploc (0.5 CTB: SPCE Maintenance Kit, S/N 1075, B/C 003957J))
3. Common Tip Screwdriver 3" (P/N SSDE43B) - NOD1D4\_G2 (Drawer 3 of ISS IVA TOOLBOX)
4. EMU Advanced Battery (P/N SV819600-02-00, S/N 2053, B/C EMUH06J) - A/L1A1 (EMU 3009)
5. EMU Advanced Battery (P/N SV819600-02-00, S/N 2062, B/C EMUH08J) - A/L1F1 (EMU 3010)

The following procedure was added to the tasklist:

### Wireless Video Systems Files Transfer and Downlink

1. 760XD laptop (P/N SDZ39129262-301, S/N 6016 B/C 00000452M) - A/L101 (M-02 Bag: EVA PREP AND OPS, S/N 1038, B/C 003019J)
2. US DC Power Cable, 10ft (P/N SEZ39129260-309, S/N 6029, B/C 00017100J) - A/L101 (M-02 Bag: EVA PREP AND OPS, S/N 1038, B/C 003019J)
3. US DC POWER SUPPLY 120V (P/N SEG39129272-303, S/N 6007, B/C POC01039J) - A/L101 (US DC Power Cable, 10ft (M-02 Bag: EVA PREP AND OPS, S/N 1038, B/C 003019J))
4. DC POWER SUPPLY ADAPTER CABLE 10' (P/N SEG39129263-301, S/N 6002, B/C 00000348M) - A/L101 (US DC Power Cable, 10ft (M-02 Bag: EVA PREP AND OPS, S/N 1038, B/C 003019J))
5. 3.0 GB Hard Drive (P/N SEZ39129266-301, S/N 5020) - LAB1O5\_E1 (1.0 CTB: LF-1 laptop equipment bag (2 of 3), S/N 1119, B/C 004113J)
6. PCMCIA 1GB Micro Drive - LAB1D3 or Crew Pref

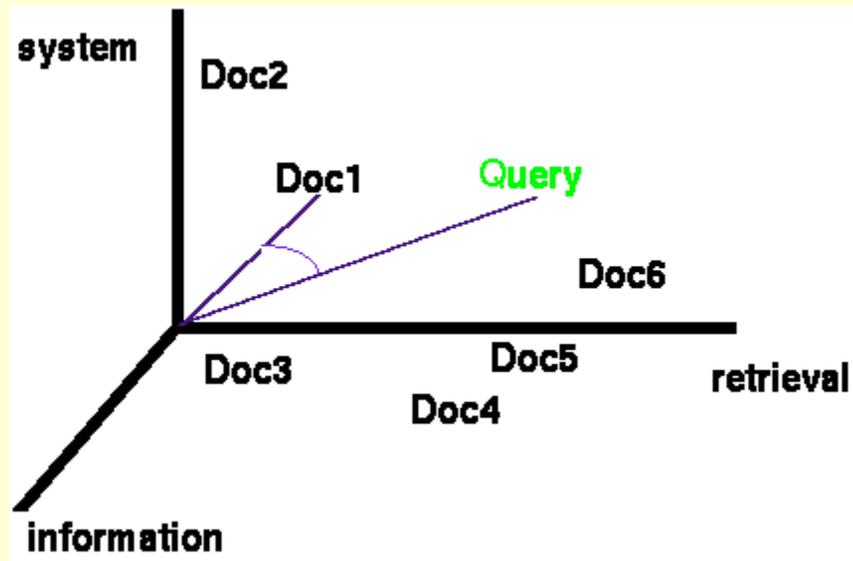
# Similarity Search

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- Goal: Find Chits (or Flight Notes or Anomalies) that are similar to a given Chit/FN/AR
- Method: Use well-known statistical methods from the field of *Information Retrieval* to analyze text and determine the degree of similarity between two blocks of text (TF-IDF *vector space method*)

# Vector Space Method

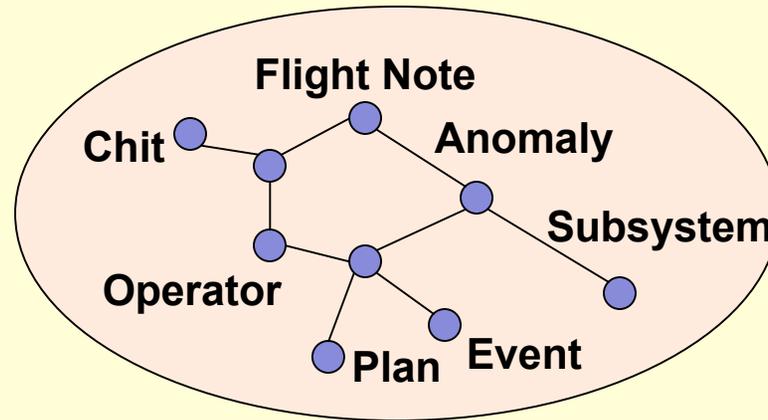
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- Model document in a multi-dimensional vector space
- Each dimension represents a term (found within some document)
- Each chit is represented as a point in the space described by a vector:  
 $\langle t_1, t_2, t_3, t_4, \dots, t_n \rangle$
- Dimensions normalized by frequency of occurrence
- Similarity between two points is measured by the cosine of the angle between their two vectors.

## Ultimate Goal:

# *Build Up Integrated Semantic Data Model*



- Provides unifying context for all mission operations information
- Supports semantic search and inference capabilities
- Leverages Semantic Web R&D