

US Forest Service Operational Loads Monitoring Program



April 22, 2008

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Background

- The US Forest Service uses aircraft for a wide variety of missions, including personnel transport, research, forest rehabilitation, law enforcement support, aerial photography, infrared detection, and fire prevention and suppression.
- The primary mission of Forest Service Aviation is to support the ground firefighter through a variety of means including safe delivery of smokejumpers, helitack, air attack, firefighter and cargo transport, surveillance, aerial reconnaissance and fire intelligence gathering, and aerial delivery of fire retardant and water.



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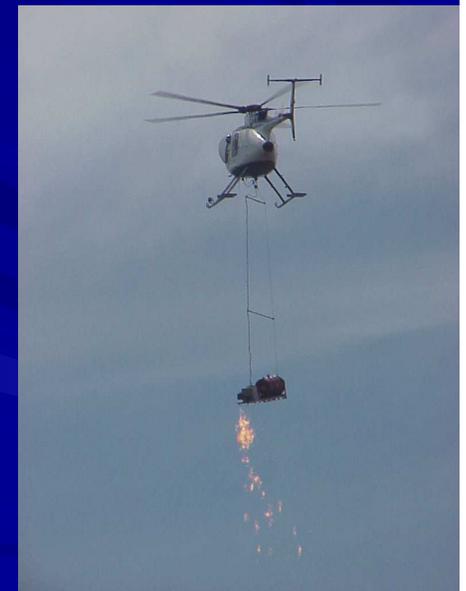
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Aerial Firefighting Missions



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Program Purpose

- This program was implemented by the US Forest Service (Fire and Aviation Management and the Missoula Technology and Development Center) for the purpose of collecting operational loads data in the low level aerial firefighting environment.
- The primary use of the data collected is to define how each aircraft is employed in the aerial firefighting role and develop detailed mission flight profiles that result in a load spectrum for each firefighting mission and allow for the sharing of this data.



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Program Purpose

- The Forest Service and the Federal Aviation Administration are collaborating in a technical exchange program in support of the FAA's Operational Loads Measurement Program.
- Through the FAA, Wichita State University's National Institute for Aviation Research (NIAR) has been tasked to identify maneuver loading and the level of turbulence experienced in the firefighting environment from data collected from airtankers operating in the firefighting environment.
- This effort will result in an FAA published report quantifying this data.



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Data is currently or will be collected for the following Missions:

■ Fixed Wing Aircraft

- *Large Airtanker
- *Aerial Supervision Module (ASM) / Leadplane
- *Smokejumper
- *Infrared Aircraft
- *Air Attack / Reconnaissance / Patrol

■ Helicopter

- Water / Retardant Delivery
- Firefighter Delivery / Rappel
- Cargo Delivery
- Aerial Ignition



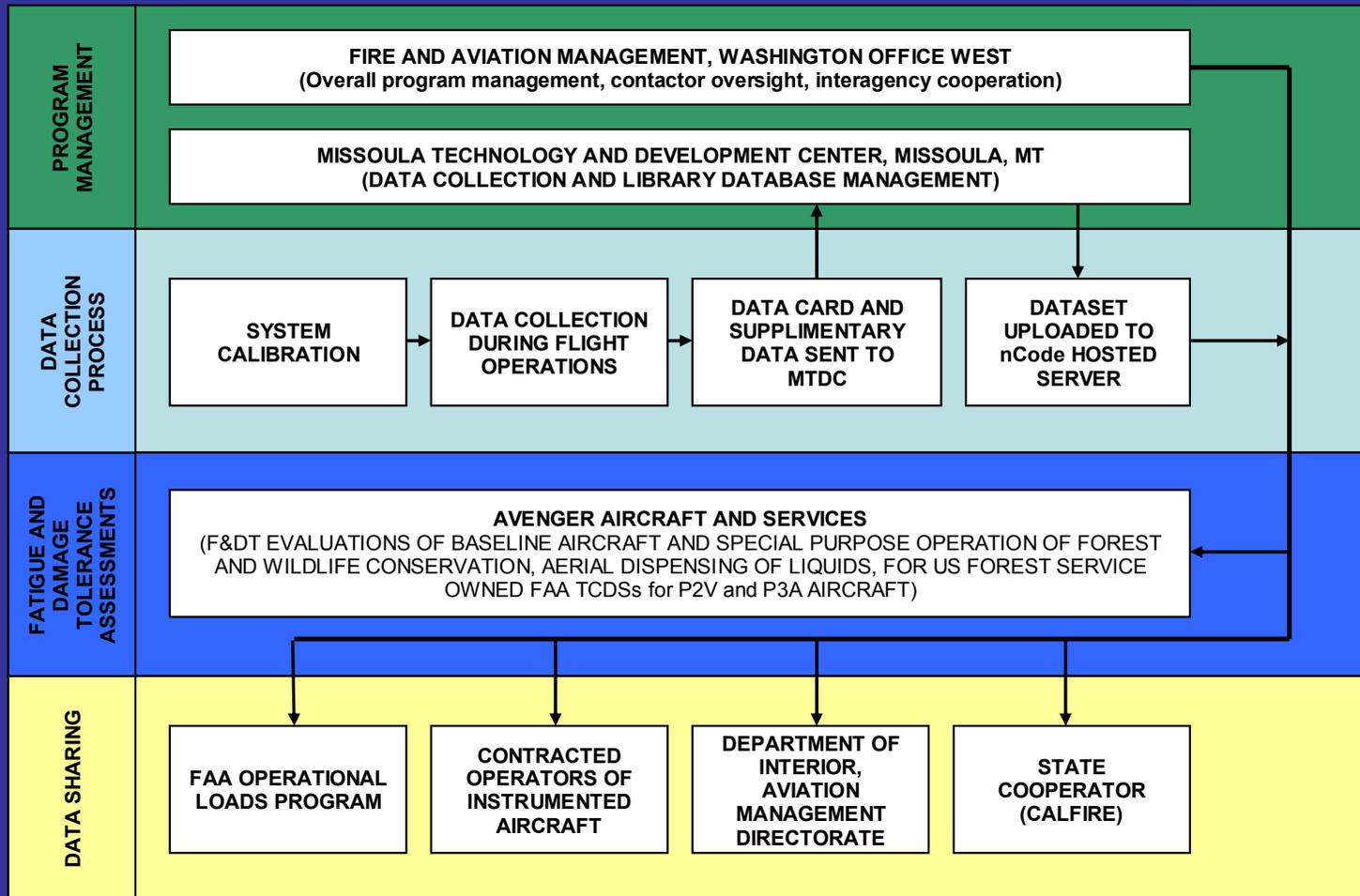
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US FOREST SERVICE OPERATIONAL LOADS MONITORING PROGRAM STRUCTURE



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SEI

Systems & Electronics, Inc.

System Hardware

■ The SEI Full system was prototyped during the 2003 fire season and has since been refined, adjusting strain sensors to more critical areas and has added additional parameters to aid in flight profile definition. Parameters recorded are:

- Date/Time GMT
- Latitude and Longitude Altitude
- Heading
- Vertical Acceleration
- Roll Acceleration
- Left Aileron position
- Elevator position
- Flap position
- Airspeed
- Fuel Load
- Aircraft Avionics power on / power off
- Aircraft Landing Gear Position
- Capable of 12 channels of Strain
- AIRTANKER SPECIFIC PARAMETERS
 - Retardant Load
 - Retardant tank door(s) actuation
 - Jet Tachometer (P2V)
 - Spoiler position (P2V)
 - Over G Indicator (P3)
 - #2 Engine On (Start / Stop Record)



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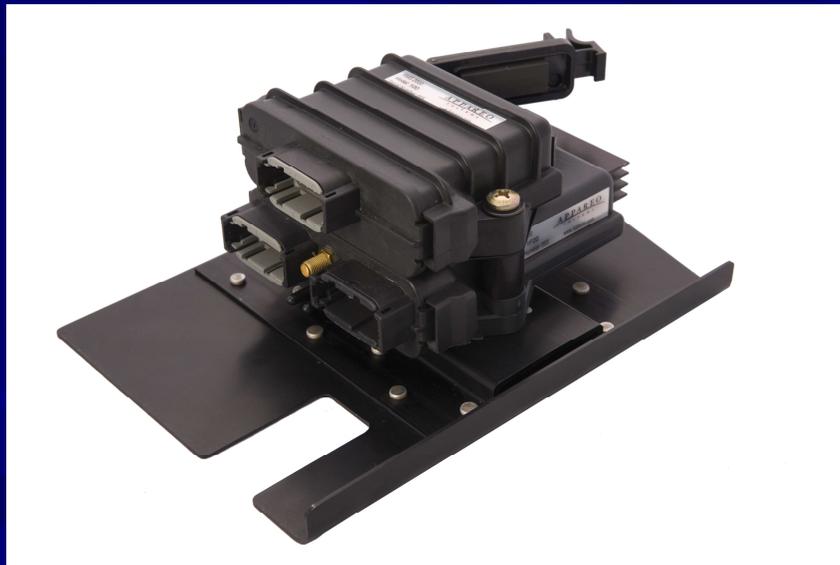
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APPAREO

S Y S T E M S

System Hardware

■ The Appareo Light Operational Loads Monitoring (OLM) System further supports the mission profile definition and loads spectra development. Parameters recorded are:



- Date/Time GMT
- Latitude and Longitude Altitude
- Heading
- Vertical Acceleration
- Airspeed
- Fuel Load
- Aircraft Avionics power on / power off
- Aircraft weight on wheels (squat switch)
- AIRTANKER SPECIFIC PARAMETERS
 - Retardant Load
 - Retardant tank door actuation



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- The OLM Library Database is a commercial off-the-shelf product supplied by nCode International of Southfield, MI. It is based on their ICE-flow Automation Test solutions, a web-based application with multilevel security protocols and access levels. It also tracks the versions of each flight record dataset stored, ensuring traceability to the original dataset.
- An additional nCode analysis tool, GlyphWorks, is used to process the collected data through different analysis "flows." This enables multiple datasets to be processed simultaneously.



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Home Screen after logging in

The screenshot shows the home screen of the nCode ICE-flow 4.1 software. The interface is divided into several sections:

- Top Bar:** Displays "Test Analysis Library" and the user is logged in as "hmatuziak". There are links for "Preferences" and "Logout".
- Toolbar:** Contains icons for "Change Password", "Report Type", "Units Calculator", "Interactive Plot", "Print Page", and "Help".
- Shortcuts:** A vertical list of actions including "New Operator", "New Aircraft", "Show List", "Add to List", "Remove from List", "Download Data", and "Upload Data".
- My Data:** A section for managing data, with a "Data Tree" view showing "USDAF Resources", "Resources", "Test Data", and "Jobs".
- Main Content Area:** A large graphic for "ICE-flow 4.1" featuring the nCode logo, the text "ICE-flow 4.1", and the website "www.ncode.com". The graphic also includes the text "©2008 nCode International".



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Individual Flight Datasets with Stored Metadata

Test Analysis Library | Logged on as LANDGWIN | Preferences | Logout

Change Password | Report Type | Units Calculator | Interactive Plot | Print Page | Help

Shortcuts

My Data

New Operator

New Aircraft

Show List

Add to List

Remove from List

Download Data

Analysis

Tools

Library - nCode ICE-flow

Project Data

Change Layout | Download | Upload | Plot Channels | CSV

Project Report

Operator: Aero Union | Airplane: Tanker 21

Object	Status	Reduced Data	Thumbnails	Stats	Attachments	View	Edit	Add
Aero Union								
Tanker 21	INITIATED							
Datasets								
20070417_000116								
0001_20070417_1639								
0003_20070417_1725								
0016_20070420_2136								
0020_20070421_1637								
0022_20070421_1659								
0023_20070421_1810								
0024_20070422_1912								
0025_20070422_2116								
0028_20070424_0000								
0032_20070424_2101								

Permissions | Attachments | Audit Trail

Name: 0014_20071124_2255

Flight details

Flight Number	0014	Elapsed Time	0 SECOND
Departure Base	FOX FIELD (WJF)	Local Flight Date/Time	11/24/07 11:15:00 PM
Arrival Base	SAN BERNARDINO (SBD)	Local Arrival Time	11/25/07 12:07:00 AM
Fuel Load	17,000 lbs	Retardent load	22,950 lbs
Take off Weight	94,950 lbs	Take off Center of Gravity	

General Remarks

Remarks

GMT Offset

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Uncategorised Properties

Run Description

Object Note

File Details

Contains raw data	TRUE	S3 Raw Data	0014_20071124_2255.s3t
S3 Clean Data		Contains reduced data	FALSE
Contains clean data	FALSE	Raw Data (Original)	{1196275834015=1196275834015_ADAPT_000116_20071022_20071128_1117_20071124_2255_FL_0014.tar}
Clean Data (Original)		Raw Upload Date	1196275834015
Generated Reduced Data		Clean Upload Date	
Uploaded Reduced Data		Reduced Data Generation Date	

Object Meta Data



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Searchable Statistics by Channel

Test Analysis Library (Logged on as LANDGM)

Change Password Report Type Units Calculator Interactive Plot Print Page Help

Shortcuts

My Data

New Operator

New Aircraft

Show List

Add to List

Remove from List

Download Data

Analysis

Tools

Library - nCode ICE-flow

Project Data

Change Layout Download Upload Plot Channels CSV

Project Report

Operator: Aero Union Airplane: Tanker 21

Object	Status	Reduced Data	Thumbnail	Stats	Attachments	View	Edit	Add
Aero Union								
Tanker 21	INITIATED							
Datasets								
20070417_000116								
0001_20070417_1639								
0003_20070417_1725								
0016_20070420_2136								
0020_20070421_1637								

Operator: Aero Union Airplane: Tanker 21 Data Cars: 20070417_000116 EventName: 0025_20070422_2118

Search Statistics by Channel

No.	Channel	ymin	ymax	yunits	mean	rms
1	Strain Gauge 1	-413.5	238.78	microstrain	-57.26	189.4
2	Strain Gauge 2	-418.01	-92.56	microstrain	-254.78	260.95
3	Strain Gauge 3	-407.68	535.6	microstrain	-38.22	144.74
4	Strain Gauge 4	-116.44	480.71	microstrain	161.11	199.82
5	Strain Gauge 5	-285.37	809.53	microstrain	324.9	421.07
6	Strain Gauge 6	-119.43	1024.12	microstrain	465.42	543.12
7	Strain Gauge 7	-86.53	968.29	microstrain	437	510.98
8	Strain Gauge 8	-209.66	1112.38	microstrain	558.98	664.68
9	Strain Gauge 9	-302.85	850.3	microstrain	324.74	394.81
10	Strain Gauge 10	-594.04	273.73	microstrain	-189.92	234.28
11	Strain Gauge 11	-1094.91	227.13	microstrain	-521.72	603.24
12	Strain Gauge 12	-361.09	978.43	microstrain	413.86	518.82
13	Roll Acceleration	-1.55	1.74	degs/sectec	-3.15E-2	0.11
14	Vertical Acceleration	0.55	1.91	g's	1.02	1.03
15	Fuel 1	795.16	5104.64	lbs	3250.42	3332.18
16	Fuel 2	647.35	4378.62	lbs	3089.96	3144.65
17	Fuel 3	549.56	2942.13	lbs	1838.4	1915.67
18	Fuel 4	1483.57	5286.11	lbs	3535.56	3600.81
19	Airspeed	-11.92	218.79	knots	126.74	140.31
20	Pressure Altitude	11.72	8368.86	feet	1884.41	2585.76
21	Flap Position	-8.64	103.25	degrees	59.71	88.89
22	Left Aileron Position	-18.54	20.06	degrees	1.68	3.25
23	Elevator Position	-28.47	16.66	degrees	-10.02	11.65
24	Fleet Position	-213.53	-196.13	gallons	-206.13	208.14
25	GPS Altitude	203.41	7827.99	feet	1831.84	2573.34
26	GPS Track	0	359	degrees	207.85	230.44
27	GPS Latitude	29.77	40.27	decimal degrees	39.9	39.9
28	GPS Longitude	-122.36	-121.8	decimal degrees	-121.97	121.97

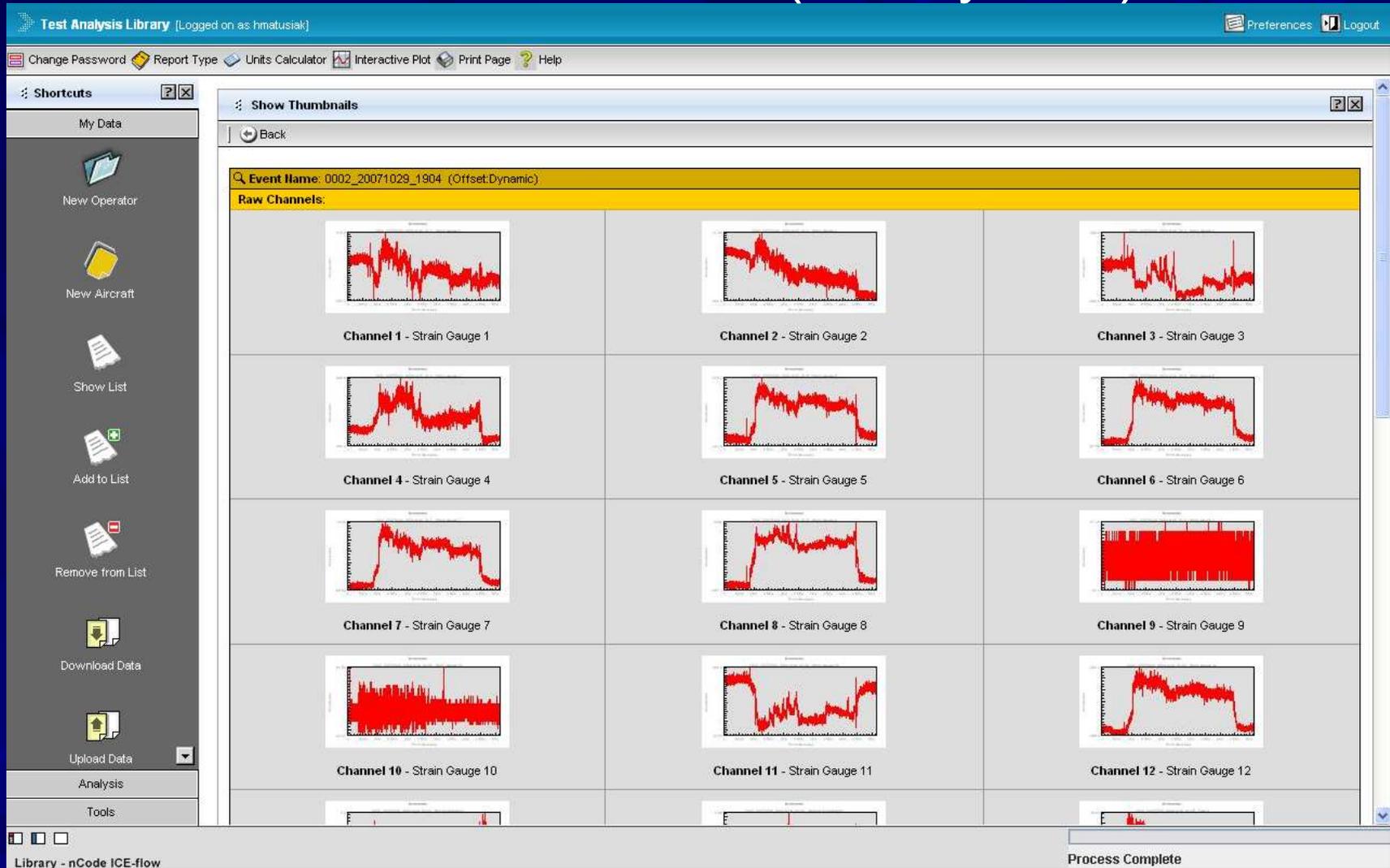


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Data Generated Thumbnails (SEI System)



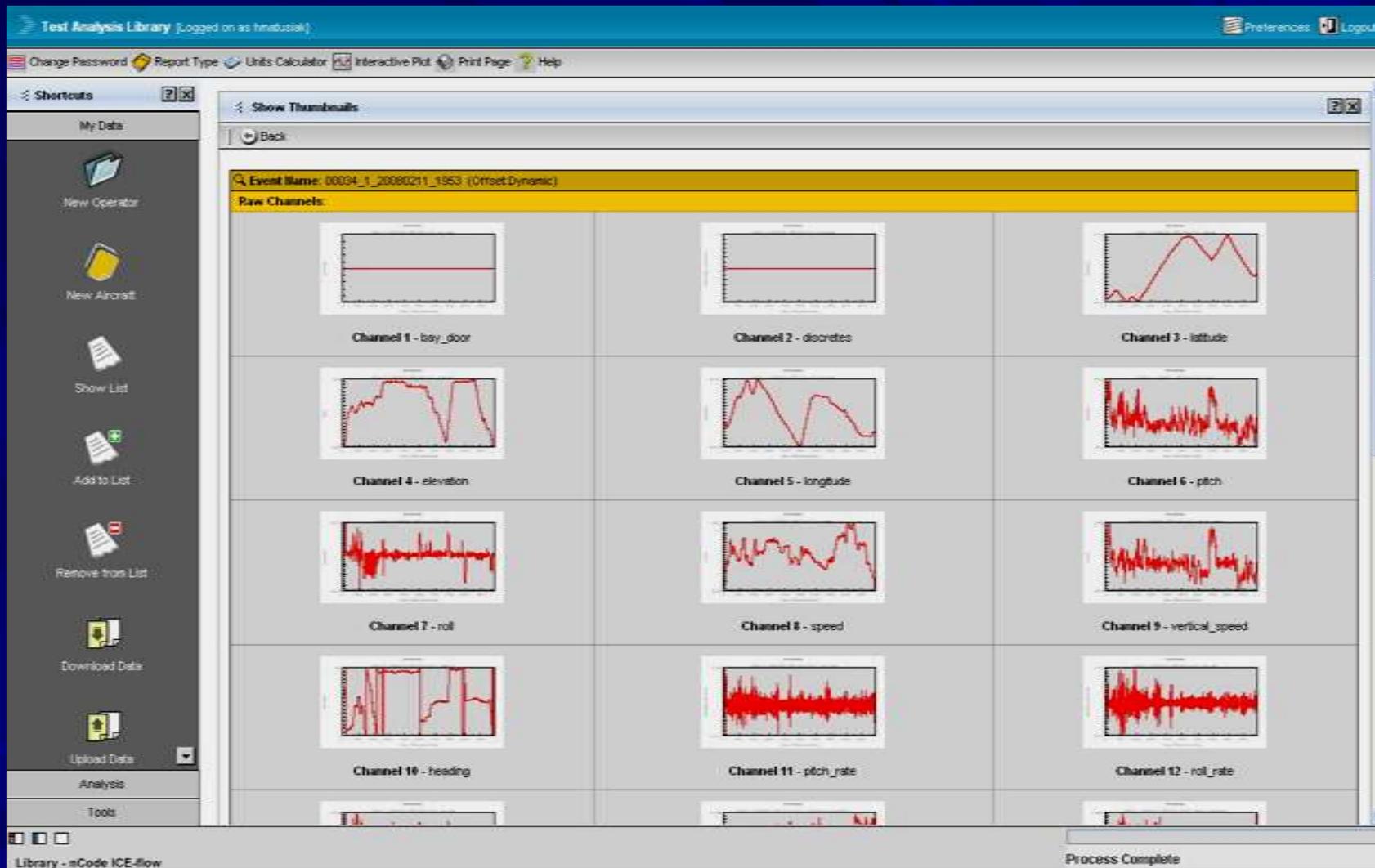
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Data Generated Thumbnails (Appareo System)



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Timeline

- 2003 - 3 aircraft instrumented
- 2004 - An additional P2V is instrumented
- 2005
 - P2V systems are reconfigured to support Fatigue and Damage Tolerance evaluation being performed by Avenger Aircraft and Services
 - Contract awarded for Full OLM system and installation to Systems and Electronics Inc
 - Contract awarded for OLM Library Database to nCode International
- 2006
 - 2 additional P2V aircraft instrumented



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Timeline

■ 2007

- APPAREO Systems awarded contract for “Light” OLM system and installation
- 7 additional Light systems installed
 - 2 Additional P3 (Airtanker Profile)
 - 1 CALFIRE S2T (Airtanker Profile)
 - 1 Forest Service DC3TP4 (Smokejumper Profile)
 - 1 Forest Service Twin Otter (Smokejumper Profile)
 - 1 Forest Service King Air 90 (ASM Profile)
 - 1 Forest Service King Air 200 (IR Profile)



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Timeline

■ 2007

- From lessons learned all systems are standardized
- Parameters collected have been modified to limit the manually collected supplementary pilot data. These parameters are:
 - Time and date in Greenwich Mean Time (GMT)
 - Lat and Long (from GPS)
 - Heading (from GPS)
 - Altitude (from GPS)
 - Fuel Load (electronically recorded if possible)
 - Retardant Level (electronically recorded if possible)



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Current Status

■ 2008

- 19 additional Light systems installed (7 in progress)
 - 6 P3 (Airtanker Profile)
 - 8 P2V (Airtanker Profile)
 - 1 Thrush 413 (Single Engine Airtanker)
 - 1 Bell 212 (*Helitack Mission Mix)
 - 1 DC3TP4 (Smokejumper Profile)
 - 1 Twin Otter (Smokejumper Profile)
 - 1 Aero Commander 500 (Air Attack Profile)
- All large airtankers contracted to the Forest Service instrumented with OLM systems



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Challenges / Achievements

■ Challenges:

- Data quality issues stemming from the integration of a digital data collection system on older aircraft.
- No lull in fire activity
- The system installations cost additional aircraft down time

■ Achievements:

- Over 2500 missions of flight data collected and matched with pilot supplementary data.
- Collected data was used to complete Fatigue and Damage Tolerance assessment of P2V and P3A aircraft for the special purpose operation of Forest and Wildlife Conservation (Aerial Dispensing of Liquids) firefighting mission.



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Conclusions

- The US Forest Service Operational Loads Monitoring Program and resultant byproducts have brought a new awareness of the impact firefighting has on aircraft performing these special missions.
- Data being collected is relevant to current usage and will have a positive effect as it is applied to establish proper inspections and corresponding intervals for firefighting aircraft. (Increased safety)
- The collection of operational loads data and its subsequent reduction and application in analysis is the key to the appropriate use of aircraft pressed into an additional or alternate usage that is beyond what the OEM originally intended.



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Questions?

