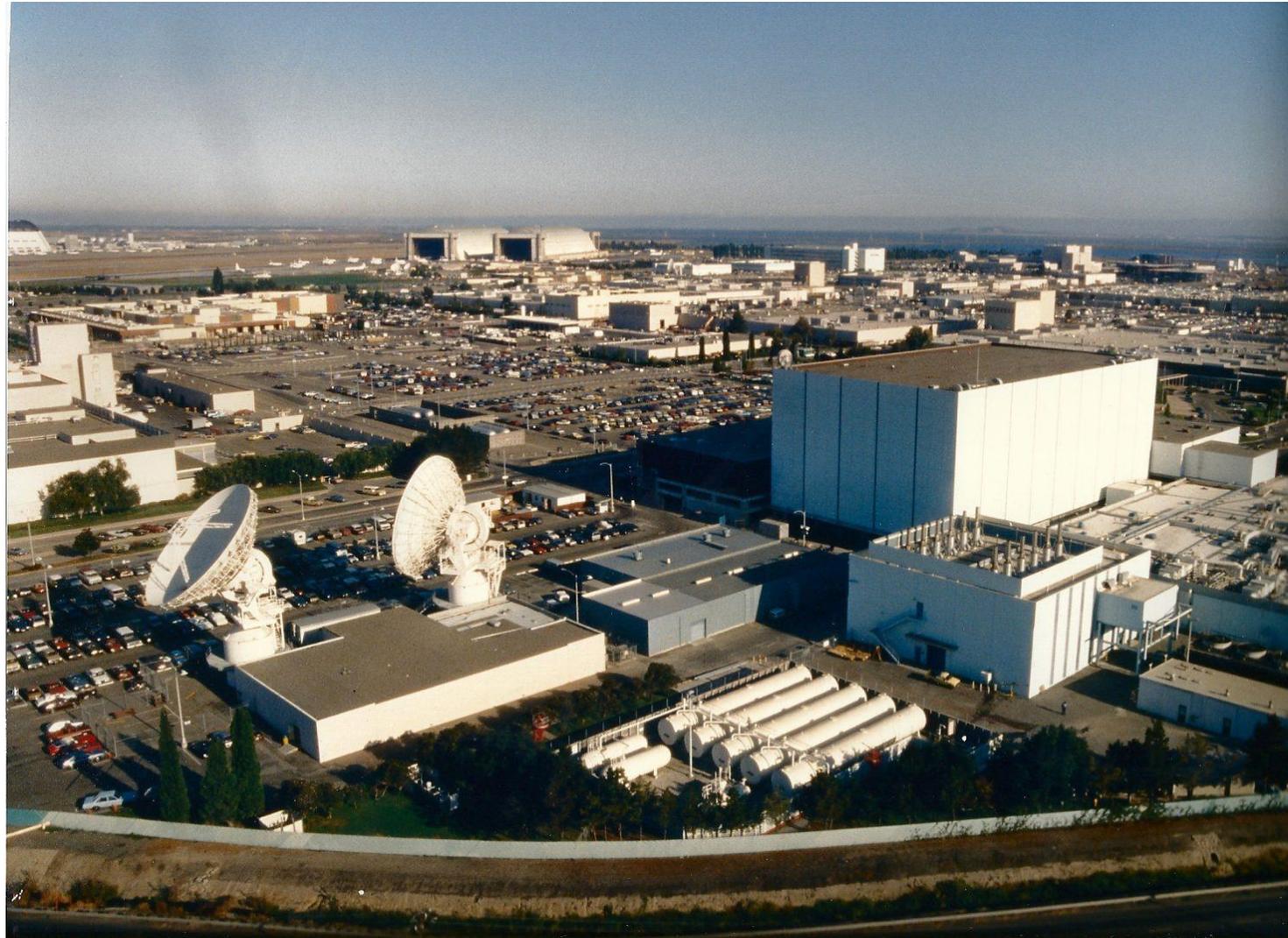# MISSION OPERATIONS
SATELLITE TEST CENTER (STC)
SUNNYVALE, CA

SATELLITE OPERATIONS
MISSION CONTROL

The **Air Force Satellite Control Facility** (**AFSCF**) was the space mission command and control unit located at Sunnyvale, California. It was the operational hub for this nation's Secretary of the Air Force Special Projects (SAFSP) satellite programs. Originally activated at Los Angeles AFS, California on 18 Jun 1965 with Satellite Test Center located at Sunnyvale, CA. The Air Force Satellite Control Facility (18 Jun 1965 – 1 Oct 1987 was later, named Onizuka AFS/AFB.

From the early 1960s to the 1980s Satellite Test Center (STC) was the center of space mission support for several DoD & NRO classified satellite systems operations providing the command-and-control function throughout mission life.

- Launch Support

- On Orbit Command & control

- Recovery Coordination

- Termination

GLOBAL SATELLITE CONTROL NETWORK LOCATIONS

| Station	Abbreviation	Call-Sign	Location	Lat	Long
New Hampshire Tracking Station	NHTS	BOSS	New Boston, NH	42.95	-71.63
Vandenberg Tracking Station	VTS	COOK	Vandenberg, CA	34.58	-120.62
Guam Tracking Station	GTS	GUAM	Guam	13.61	144.86
Hawaii Tracking Station	HTS	HULA	Kaena Pt Oahu, HI	21.56	-158.24
Indian Ocean Tracking Station	IOS	INDI	Mahe, Seychelles	-4.66	55.49
Kodiak Tracking Station	KODIAK	KODI	Chiniak/Kodiak, AK	57.47	-152.46
Thule Tracking Station	TTS	POGO	Thule, Greenland	76.52	-68.60
Satellite Test Center		STC	Sunnyvale, CA	37.40	-122.03
Oak hanger Tracking Station		TCS	Oak Hanger, England	51.12	-0.96

GLOBAL SATELLITE CONTROL NETWORK

(Remote Tracking Station Locations)

The STC was the focal point of a global network of remote tracking sites (RTS)

REMOTE TRACKING STATIONS SCHEDULING
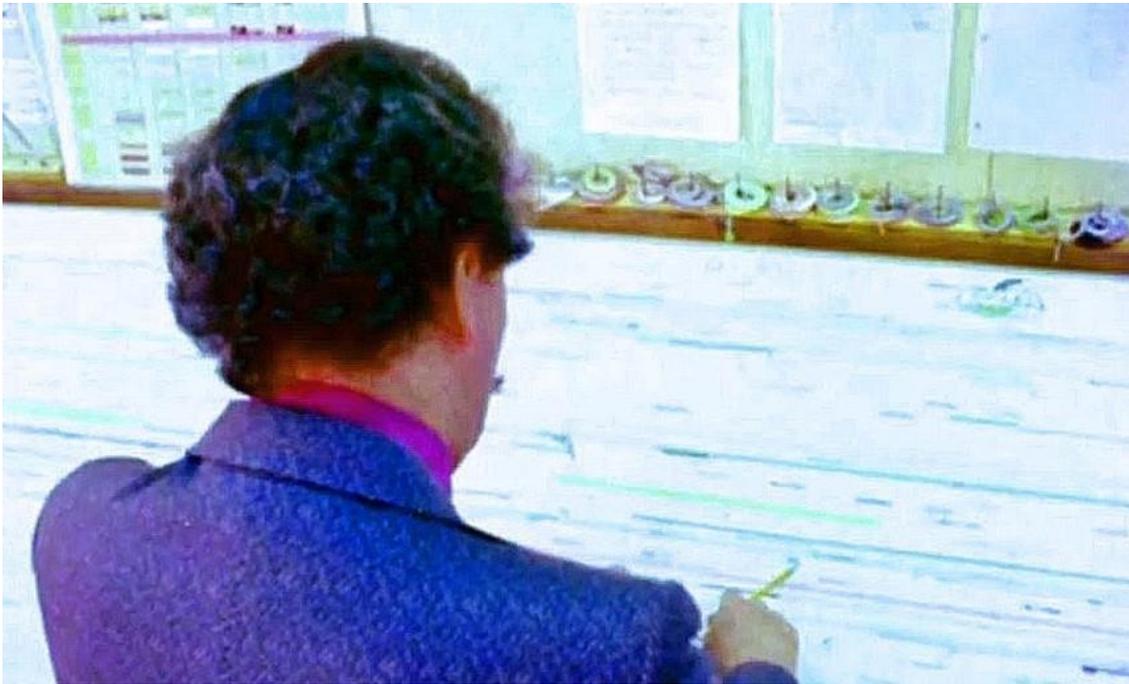
Remote tracking Stations (RTS) were used by several satellite programs and were scheduled by those programs to share these common assets most efficiently. This schedule was planned on long butcher paper with colored chart tape. Simple but effective.

SATELLITE CONTROL FUNCTIONS

The Satellite Control Facility performed several functions in support of space operations.

- Launch Countdown Support
- Early Orbit Deployment/Checkout
- On Orbit Mission Operations
  - Primary Mission Command Control
  - Telemetry Monitoring
  - Tracking
  - Orbit Adjust
  - Anomaly Resolution
- Reentry Vehicle Recovery
- End of Mission Activities & Deorbit

STC LAUNCH OPERATIONS SUPPORT

- Generate command sequence for rev "0"
- Support pre-launch payload checkout
- Evaluate ascent dynamic loads "Winds aloft"
- Monitor countdown & confirm "go" for launch
- Configure ground computers for orbit operation support
- Confirm satellite function, health & status during first station pass
- Release/approve for mission operations

ON ORBIT MISSION OPERATIONS

- Satellite operations were tasked with computer generated command sequences produced by the programs written by the command generation (CG) teams. CG incorporated inputs for target priority, position, weather & other status conditions. Each command message was loaded during a station pass for execution during the next orbit.
- Satellite computers were primitive by current standards that required each function to be programmed with a time tagged command for later execution
  - A single image operation required dozens of precisely timed discreet commands
  - CG teams used CDC-3800 computers but the output was then checked by teams of engineers before being sent to the RTS for loading into the satellite
  - Command sequences were sent to the RTS by datalink with a CDC-160 "Bird Buffer" for loading during the upcoming station pass
- The state-of-the-art computers at the time were primitive by today's standards. The ground support team had to be highly skilled to operate satellites safely & effectively.

EACH COMMAND SEQUENCE WAS "PROGRAMMED" WITH KEYPUNCH CARDS

THE CDC 3800 WAS STATE OF THE ART

The computers were state of the art for that time but not compared to what we have today.
Each function had to be programmed with punch cards, for example a photo operation required 16 commands to execute. The output then had to be checked & verified manual on 128 column paper printouts.
The resulting command tape was carried from the CDC-3800 to the "Bird Buffer" computer link to be sent to the RTS to load into the satellite on the next station pass.

Spec	CDC 3800	Dell Inspiron Corei7	Ratio
Architecture bits	48	64	1.3
Brand Name	CDC 3800	Dell Inspiron Core i7	NA
Clock speed Hz	1,000,000	4,600,000,000	4,600
Cost	$ 1,900,000	$1,300	1,462
Graphics Coprocessor	None	Intel UHD 620	NA
Hard Drive Capacity	300,000	512,000,000,000	1,706,667
Item Weight	Tons	3.86 pounds	4,000
Max Screen Resolution	None	3840 x 2160	NA
Memory	512,000	16,000,000,000	31,250
Operating System	JOVIAL	Windows 10 Pro	NA
Platform	Mainframe	Lap-top PC	NA
Power Source	Utility Powered	Battery Powered	NA
Processor Count	1	4	4
Processor Size in^3	147,600	0.5	295,200
RAM (bits)	200,000	16,000,000,000	80,000
Technology # Transistors	40	1,750,000,000	43,750,000

CDC-3800

MISSION OPERATIONS
COMMAND GENERATION CYCLE (REPEATED FOR EACH SATELLITE REV)

Timeline Minutes	Ground Operation Events	Satellite Operation	Comments
0	Prepare Engineering Commands		
5	Receive Predicted Weather Data		Data from previous rev weather satellite
10	Received Target Priority List		
15	Plan Image Tasking		Prioritize Target selection
20	Generate & Check Satellite Commands		All Inputs made on punch cards
25	Send Command sequence to ground station		
30	Station Pass - Communicate with & command satellite	Communicate with Ground Station	Verify health, Readout Recorder (Telemetry & Command Sequence), Load Command Sequence. Turn off Transponders (Duration 2 to 4 minutes)
35			
40	Verify Command Execution History based on telemetry		
45	Update Orbital Position based on tracking data	Satellite Imaging Operation	Engineerng operations conducted during non imaging orbits
50	Evaluate Health & Status		
55	Plan RV recovery, Orbit Adjust, Engineering Events		Engineerng operations conducted during non imaging orbits
60	Address any operational anomalies		
65	Verify imaging success based on updated cloud coverage & camera operation	Verification Weather Satellite Pass	
70			
75	Update ground simulation records with satellite data		
80			
85		Predicted Weather Satellite Pass for next orbit rev	
90			
	Repeat Sequence 16 Times a day!		

THE STATION PASS

Each satellite station pass lasts only 2 to 5 minutes, during which several functions must be performed. The Field Test Force Director (FTFD pronounced "Foot Fudd") coordinates these events from the STC.

- The station confirmed contact with the satellite & tracking began
- Telemetry & satellite health status was verified
- The vehicle tape recorder was read out to verify all previous commands were executed
- The new command sequence was loaded in the satellite & verified into the vehicle memory
- The satellite tape recorder was turned off
- The command system was shut off – (Satellites then executed timed commands outside of station contact)
- If an anomaly (Abnormal satellite status) was detected during a station pass, the satellite was put in a "safe" mode (limiting functions) until the issue could be resolved and corrected at the next station pass.
  - Passes were too short to resolve a complex issue in real time
  - Technical teams had to work quickly to address and correct the issue before the next station pass

MISSION CONTROL COMPLEXES

Program-specific Mission Control Complexes (MCCs) at the STC were the operational link to the Remote Tracking Station (RTS) activities during a satellite pass. Several engineers monitored the satellite health & status while the controller directed the telemetry read out, the command load and real time operation functions.
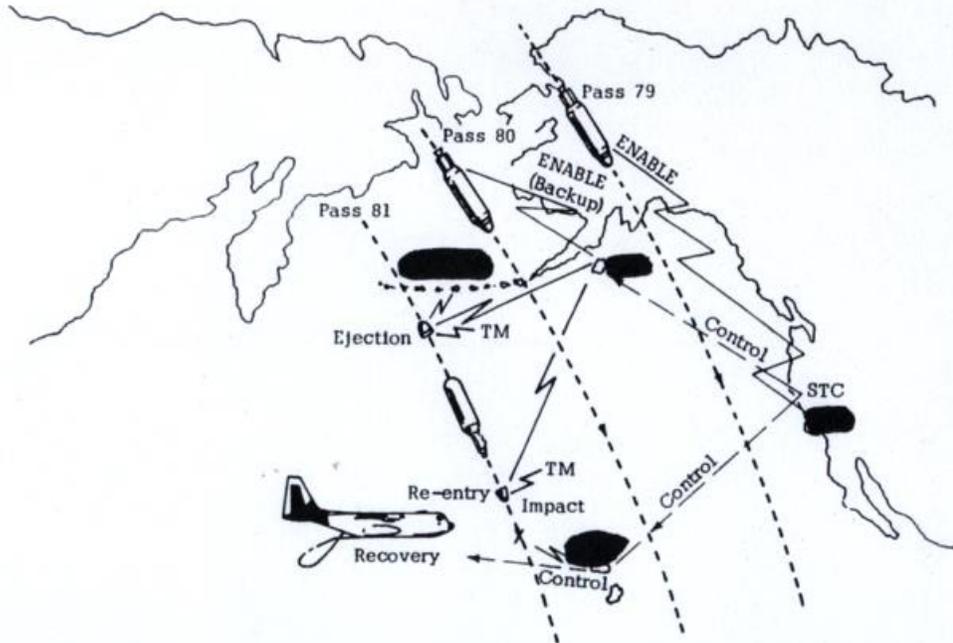
POST PASS

After each satellite station pass, in preparation for the next pass, the STC must update the computer with the downloaded telemetry data including tracking information and vehicle status to assure the computer model on the ground accurately reflected vehicle configuration and status. The next command generation sequence then begins. This ground command and control sequence is repeated several times each day requiring an hour of diligent preparation punctuated by a few minutes of stressful contact during those brief RTS passes.

The CDC-3800 built future commands based on a virtual model of the satellite configuration on orbit and had to be updated with the historic command executions and position of the actual hardware to accurately plan the next operations.

RV RECOVERY

When a reentry vehicle (RV) "bucket" from an IMINT program was filled with film, it was returned to be processed. The operation required coordination with the 6594th Recovery Group to "*catch a falling star.*" At the correct position in orbit the satellite was pitched down and ejected the RV to begin its reentry sequence. These events were monitored by KODI RTS. The RV sequence executed autonomously and was caught mid-air. If the chute was damage and could not be caught, a helicopter performed a water recovery. The STC commanded the satellite, coordinated & confirmed execution of this complex recovery operation.

SATELLITE CONTROL FACILITY OPERATION IN RECOVERY

Pass 79
Pass 80
ENABLE
ENABLE (Backup)
Pass 81
Ejection
TM
Control
STC
TM
Re-entry
Impact
Control
Recovery
Control

SOLO MISSION OPERATIONS

After all the RVs have been deployed, the primary mission for IMINT satellites is over. The satellite could then be stressed in ways that would otherwise compromise operations to test and verify basic support system integrity. These solo operations were relatively brief. After tests were completed, the satellite is deorbited to burn-in on reentry in a remote area over the ocean where it would not be a hazard and could not be recovered.

Satellite designs implemented emerging technology that improved operations and were "tested" in conjunction with mission operations.

SATELLITE CONTROL NETWORK SUPPORT

The STC supported several DoD and NRO satellite programs with its global network assets. The state-of-the-art computer and spacecraft technology at the time was primitive by today's standards requiring an exceptional level of human expertise. Despite this, the resulting mission accomplishments (50+years ago) are still exceptional by today's standards.

Many SAFSP support organizations, most without full knowledge of specific missions, enabled a rapid acceleration of intelligence collection from space. The projection of defense satellite utility was to the credit to those engaged in network support.

AIR FORCE SATELLITE CONTROL FACILITY