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4564-72

TO: [redacted] cc: See Below

9 November 1972

SUBJECT: P-989 Historical Summary and Aerospace Support

FROM [redacted]

This report provides a current one-page summary of each P-989 system. It is an update of BIF-107W-44059-70.

The following is a brief history of Aerospace activities in P-989 and related efforts.

The P-11 piggyback satellite was conceived and designed by LMSC in 1962 to fit the Agena aft rack for cheap rides. The first two launches in 1963 were Van Allen Belt probes specified by Aerospace Labs, who also dictated the tasking and processed the data. Four of the other early P-11's were Pundit telemetry collection systems contracted by [redacted] from Sylvania, EDL. The only other associate contracts for payloads were with Stanford (SEL) for the Fanion and Sampan payloads.

In July 1964, the Aerospace 770 Program Office was formed under [redacted] to support Col. Yundt in the changeover of the 698 BK Program to the 770 Program, and in the development of the AIL Multigroup and the LTV Setter payloads. Also, Maj. John Copley who had managed the P-11 program was succeeded by Maj. Jack Kulpa (7-64 to 3-65), and [redacted] from NSA was given a field assignment with Yundt's office. The [redacted] codeword, Eardrop, and the NRL codeword, Poppy, were dropped for a common codeword, Earpop.

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In the spring of 1964, [redacted] approved the development of a two-burn P-11 with a horizon sensor and sun sensor for attitude reconstruction to support the geoposition capability of the SEL proposed Fanion payload. In the fall of 1964, Yundt asked [redacted] for Aerospace technical surveillance of the P-11 Program. [redacted] was assigned, and subsequently evaluated the LMSC

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hardware and software for P-11 attitude reconstruction, established a new P-989 altitude of 270 NM, helped establish the requirements and formats for spacetrack ephemeris determination, coordinated LMSC and NSA approaches to spacetrack ephemeris use, and evaluated old proposals for a Boeing Poppy type system (SPADS) and for a switch of P-11 readout from the SCF to either the Poppy ground stations or the P-417 ground stations (per request from Dr. McMillan, DNRO). [redacted] later asked for an Aerospace evaluation of the Fanion payload proposal. This was performed by [redacted] with Labs personnel support.

The first dual burn P-11 was the 4401 Pundit system. It carried a horizon sensor and sun sensor to check out the 4402 Fanion/Tripos attitude reconstruction software packages. After launch in April 1965 its spin axis unexpectedly showed a significant precession rate. Aerospace correctly identified the cause as interaction of the vehicle magnetic moment with the earth's field and proposed consideration of commandable spin axis and spin rate control on future P-11's. Tivoli III in 1970 had the first P-11 spin axis control system, and Arroyo in 1971 had the first spin rate control system. 25X1

Aerospace next evaluated LMSC proposals for magnetic and dynamic balance of the P-11 and for using three sun sensors to obtain a direct on-orbit measurement of spin-axis offset from body coordinates. Aerospace also evaluated LMSC software proposals for 4402 on-orbit geoposition bias analysis and for modelling spin axis drift as a function or orbital magnetic, gravity gradient, and drag torques.

After the launch of the 4402 Tripos/Fanion, [redacted] attended many NSA software progress meetings and provided mathematical models for several subroutines. It was eight months after launch before NSA had the Tripos software working. In the meantime, SAC was assigned the responsibility for Fanion processing and was routinely geopositioning [redacted] to [redacted] accuracy. SAC's only primary processing role in Sigint satellite history was for the three P-11 Fanion payloads. The Fanions were the only P-11's sold as EOB systems until the 1972 Ursala system. 25X1

The [redacted] P-11 director from 6-65 to 4-66 was L/C Charles Lamb. The LMSC director from program inception through FY 66 was [redacted] In the summer of 1965 Aerospace was asked to evaluate the potential of PRF Doppler as a radar geopositioning technique. This resulted from the exposure of NRO staff members to several reports by [redacted] of the Aerospace Labs Division on the results of a cooperative PRF Doppler experiment which flew on the final P-11 Van Allen belt probe. [redacted] delivered the Labs Division computer program to NSA and estimated that the technique should work well in a light environment against stable PRF emitters, but that it required a lot of data processing per geoposition and would result in roughly [redacted] accuracy. On this basis the 4404 Plicat payload was configured to use the technique against the Hen House radar. [redacted] worked with LMSC programmers to code the necessary math for evaluation of the technique against Cal van data. The 4404 system subsequently failed prior to any data return. Poppy PRF Doppler processing has produced roughly [redacted] accuracy.

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The final P-11 associate contracts for SEL payloads were for Sampan I and Sampan II. In January 1966 [redacted] and Labs personnel evaluated the Sampan I proposal. Later in the year the LMSC [redacted] Office was formed under [redacted] and took the better people from the P-11 organization. The subsequent series of P-11's (4404, 4405, 4406, 4408, and 4410) had serious subsystem failures within the first three months on orbit. The 4405 Sampan/Sousea system lost its horizon sensor at launch, and work-around schemes to determine spin position were defeated by slight variations in P-11 spin rate within each orbital revolution. Hence, the primary mission of locating S and X-band radars was a failure.

In 1965/66, the P-11 program was redesignated P-770B, then P-989. From January 1965 through November 1966 the Aerospace support to P-989 consisted of evaluations of the new 1 MHz recorder development

and the new 39 command system plus continuing support in the operations area from the Satellite Control Office. The [redacted] director of P-989 from 4-66 to 7-70 was Maj. Frank Penney who was promoted to Colonel during that period.

In December 1966, Aerospace generated statistical probability of intercept data for P-989, P-770, and Poppy to help [redacted] propose a quick reaction response to the ABM/AES problem. Bradburn used these data to justify an ABM/AES series of P-989 systems to fly in 1967/68 and delegated [redacted] as his representative on the Harry Davis committee to serve as a consultant to the probability subcommittee. 25X1 25X1

The last of the original ABM/AES P-989's was the Vampan 100-1000 MHz spinning interferometer. This was the only P-989 in the series for which LMSC went out for competitive bid. For different reasons, AIL and TRW no-bid it. In a competition between LTV, EDL, and GE (Utica), LMSC picked GE, and Aerospace picked EDL. Maj. Kranske disallowed GE and Bradburn directed LMSC to award it to EDL.

In the fall of 1967 following the [redacted] go-ahead, Aerospace studied low altitude program requirements and recommended cancellation of P-770 and a future program of P-989 plus a new competitive three-axis stabilized piggyback. To avoid the startup costs of the latter, this was changed to a four P-989 per year recommendation which was the solution dictated later by Dr. Flax, DNRO. 25X1

In the fall of 1967 Aerospace studied possible boosters for dedicated launches of P-989 and recommended dual launches with TAT/Burner II's. LMSC studied the same problem and recommended four at a time on Thorad/Agena's. Piggyback rides with P-846 were negotiated and the problem disappeared.

In the first half of 1968 Aerospace provided detailed direction to LMSC for the development of the 4420 Tripos/Sousea 4-12 GHz spinning pencil beam data processing package. NSA (Ray Potts) concurred with the assignment of 4420 as the first P-989 for which LMSC would have primary processing responsibility on the basis that Aerospace would provide detailed support to LMSC, and that the ABM series had provided a processing overload at NSA. The LMSC response to Aerospace direction was somewhat slow, and production processing of 4420 data did not begin until five months after launch. In the meantime, NSA also assigned LMSC processing responsibility for the Vampan spinning interferometer P-989 system.

With the development of the Avco 39 command system for all P-989's after 4406 (which was supported by [redacted] in the Satellite Control Office), [redacted] contracted with PRC for a command software package. SETD for this package and mods to it was provided by [redacted] In July 1968 [redacted] also formed a group for providing SETD over the MADS contract which covered LMSC spin-axis determination, command history generation, time correlation, and Cal van analysis for all P-989's plus primary LMSC processing for 4420 and 4413, as well as the P-770 Strawman systems. 25X1

Since mid-1968 Aerospace has been very active in the P-989 payload proposal and design areas. [redacted] recommended many of the vehicle and payload changes associated with the conversion to heavy P-989's, S-Band downlinks, and the follow-on ABM systems such as Tivoli II and III. A paper by [redacted] on telemetry sampling was viewed by [redacted] as instrumental to the approval of Savant II (4419). Aerospace proposed the basic configurations for Tophat (4423), Arroyo (4427), and Mabeli (4424) and provided the prime sales pitches which resulted in the approval of these and later systems.

In January 1970, [redacted] of the Aerospace P-98 office and Labs personnel correctly analyzed the causes of the P-989 Watkins-Johnson S-band transmitter warmup problems, although LMSC had failed to do so after a $150K four-month effort. An Aerospace fix was implemented in all new units, and an off-the-shelf Conic transmitter identified by Aerospace

was flown as a backup. The Conic transmitter has since replaced the Watkins-Johnson unit, and a new unit designed to LMSC spec. by Teledyne is under test. As a result of Aerospace recommendations, a new SGLS command/telemetry unit has also been developed. Since 1969, [redacted] of Aerospace has provided strong technical support to LMSC in the design of a new launcher to interface with current P-467 piggyback rides, in a recorder improvement program, in the paper designs of various expanded power systems, and in other mechanical areas. In June 1971, [redacted] replaced [redacted] as head of the Aerospace P-98 office and has since coordinated direction of the LMSC P-989 effort, headed since 1967 by [redacted] joined the Aerospace P-98 office in the fall of 1971. This current team has greatly expanded the Aerospace effort to achieve improved reliability and performance of the P-989 systems and in directing the current block change to a heavier and more capable spacecraft design.

The [redacted] director of P-989 from 7-70 to 12-70 was L/C Gene Jakes who was promoted to Colonel during that period. The director since 12-70 has been L/C Don Wipperman who now heads a [redacted] program office (up from [redacted] in 1971). The Aerospace commitment has grown from 1 man in FY 64 to 2 men in FY 66 to 3 men in FY 68, to 4 men in FY 70, to 5 men in FY 71 to 6 men in FY 72. The LMSC program office has roughly 250 men. The current annual program budget is $22M.

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cc: L. Allen, Jr.
[redacted]
J. Copley
[redacted]
R. Kohlhaas
[redacted]

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SUMMARY OF P-989 SYSTEMS

Veh. No.	Name(s)	Launch	Life(Days)	Mission/Target
4051	Hitch Hiker	3-18-63	0	Van Allen Belt
4201	Hitch Hiker I	6-26-63	75	Van Allen Belt
4001	Pundit I	10-29-63	237	Type B TLM
4101	Pundit II	12-21-63	81	Type B TLM
4301	Noah's Ark	7-6-64	126	ABM Search
4202	Hitch Hiker II	8-14-64	730	Van Allen Belt
4102	Pundit III	10-8-64	0	Type B TLM
4302	Step 13/Plymouth Rock	10-23-64	123	150-230 MHz/1000-2650 MHz
4401	Pundit IV	4-28-65	810	[redacted] 25X1
4402	Fanion I/Tripos I	6-25-65	630	4000-8000 MHz Search
4403	Magnum	8-3-65	585	100-250 MHz ABM
4404	Leige/Plicat	5-14-66	0	168-178 MHz/153-162 MHz
4405	Sampan I/Sousea I	8-16-66	424	2000-4000 MHz/8000-12000 MHz
4406	Fanion II/Tripos II	9-16-66	82	4000-8000 MHz Search
4408	Slewto/Pennon	5-9-67	94/75	Hen House TI/[redacted]
4409	Savant I	6-16-67	494	Types B&M TLM (Pre-D) 25X1
4410	Facade	11-2-67	97	250-2250 MHz ABM
4412	Tivoli I	1-24-68	469	100-4020 MHz ABM TI
4411	Lampan I/Sampan II	3-14-68	368	1000-4000 MHz Search
4420	Tripos III/Sousea II	6-20-68	569	4000-12000 MHz Search
4413	Vampan I	9-18-68	374	100-1000 MHz ABM Search
4414	Aztec I	-	-	Optical Surface Evaluation
4415	Aztec II	-	-	Optical Surface Evaluation
4416	Calsat	-	-	SCF Calibration
4418	Tivoli II	3-19-69	520	50-4020 MHz TI (Pre-D)
4417	Lampan II/Sampan III	5-1-69	291	1000-4000 MHz Search
4419	Savant II	9-22-69	601	Types B & M TLM (Pre-D)
4407	Weston	9-30-69	321	[redacted] 25X1
4422	Tivoli III	3-4-70	577	50-4020 MHz TI (Pre-D)
4421	Tripos IV/Sousea III	5-20-70	-	4000-12000 MHz Search
4423	Tophat	11-18-70	-	450-1000 MHz Tropo Copy
4427	Arroyo	9-10-71	30	Microwave Map
4424	Mabeli	1-20-72	-	ABM Main Beam TI
4425	Ursala I	7-7-72	-	2000-12000 MHz EOB
4426	Ursala II	3-73	-	2000-12000 MHz EOB
4428	Tophat II	1-74	-	450-1000 MHz Tropo Copy
4429	Raquel	3-74	-	4000-18000 MHz Search/TI
4430	Ursala III	1-74	-	2000-12000 MHz EOB
4431	Ursala IV	1-75	-	2000-12000 MHz EOB

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(1) 4051 - HITCH HIKER - VAN ALLEN BELT PROBE

LAUNCHED:	18 March 1963 on first P-162 TAT/Agena D (1164)
ORBIT:	No orbit - booster failed
SPONSOR:	Aerospace Corporation - Laboratory Division
RECORDER:	Leach Two-Track 12/1 - 100 KHz Recorder
ANTENNAS:	Quarter wave stubs for command and TLM
VEHICLE DESCRIPTION:	Weight = 230.8 lbs. (incl. 43.1 lb. P/L) plus 39.2 lb. launcher Thiokol 83 lb. TE-345 kick motor for 2000 NM apogee 72 fixed solar arrays for 260 w-hr/day (72 cells/array) 7 tone Zombie 136 MHz command system Gas bottle spin system for 60 rpm Two LMSC 240 MHz telemetry transmitters LMSC battery, pyros, command system, launcher, power control unit, and antennas Size: 35" x 35" x 13" with rounded shoulders to fit under Agena shroud

DATES:		
	Mission Approval:	Fall of 62
	P/L Contract Award:	Fall of 62
	P/L Delivery:	January 63
	USAF Buy-off:	14 March 1963

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(2) 4201 - HITCH HIKER - VAN ALLEN BELT PROBE

LAUNCHED:	26 June 1963 on P-162 TAT/Agena D (1166)
ORBIT:	185 x 2230 NM at 82.1° inclination
DECAY:	By January 1970, apogee had decayed to 2090 NM
OTHER DESIGNATIONS:	Hitch Hiker 1, 1963 - 25B
SPONSOR:	Aerospace Corporation - Laboratory Division
CONFIGURATION:	Same as 4051 Hitch Hiker
FAILURES:	25 days - Status Commutator 37 days/247 cycle - Recorder (continued to transpond data) 75 days - Power supply (low voltage cut-off) 75 days was too short to generate good Van Allen Belt map

DATES:		
	Mission Approval:	September 62
	P/L Contract Award:	September 62
	P/L Delivery:	March 63
	USAF Buy-off	26 April 1963

(3) 4001 - PUNDIT I - TELEMETRY SYSTEM

LAUNCHED:	29 October 1963 on P-162 TAT/Agena D (1601)
ORBIT:	160 x 324 NM at 90° inclination
DECAY:	23 May 1965 (18.8 months)
OTHER DESIGNATIONS:	1963 - 42B, MSN-7301
PAYLOAD CONTRACTOR:	EDL (Sylvania), Mountain View, Calif.
MISSION:	[redacted] 25X1
TECHNIQUE:	Recognize, video detect and stretch pulses First use of two recorders, four transmitters (232, 236, 240, and 252 MHz)
RECORDER LIFE, DAYS/CYCLES:	Leach 100 KHz 4/1 - 237D/1502 cycles Leach 100 KHz 2/1 - 9D/56 cycles
PAYLOAD ANTENNAS:	12 inch Loop, 18 inch monopole
TIMER:	Adcole binary clock with 4 fixed time delays for P/L turn-on, up to 30 minute delay to turn-off
WEIGHT:	180 lb. (incl. 32.3 lb. P/L) plus 40 lb. launcher Thiokol TE-344 kick motor for 300 NM apogee Other subsystems same as 4051 Hitch Hiker
LIFE:	237 days to final recorder failure
OTHER FAILURES:	None - Status checks continued until reentry; marginal mission - few useful intercepts

DATES:		
	Mission Approval:	9 January 63
	P/L Contract Award:	23 August 63
	P/L Delivery:	4 October 63
	[redacted] Buy-off	25 October 63 (L/C Copley/Capt. O'Connell) 25X1

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(4) 4101 - PUNDIT II - TELEMETRY SYSTEM

LAUNCHED:	21 December 1963 on P-162 TAT/Agena D (1168)
ORBIT:	180 x 225 NM at 64.5° inclination
DECAY:	7 November 1964 (10.6 months)
OTHER DESIGNATIONS:	1963 - 55B, MSN - 7302
PAYLOAD CONTRACTOR:	EDL (Sylvania), Mountain View, Calif.
MISSION:	[redacted] 25X1
CONFIGURATION:	Same as 4001 Pundit I, except new solar array current monitor and 76 fixed solar arrays vs 72 on Pundit I
WEIGHT:	185 lb. (incl. 34.5 lb. P/L) plus 40 lb. launcher
RECORDER LIFE, DAYS/CYCLES:	Leach 100 KHz 4/1 - 77D/220 cycles Leach 100 KHz 2/1 - 3 D/8 cycles
OTHER FAILURES:	Solar array monitor at launch 6 days - one of the four transmitters 81 days - turned off - few useful intercepts
DATES:	Mission Approval: 9 January 63 P/L Contract Award: 23 August 63 P/L Delivery: 14 November 63 [redacted] Buy-off: 17 December 63 25X1 (L/C Copley/Capt. O'Connell

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(5) 4301 - NOAH'S ARK - ABM SYSTEM

LAUNCHED:	6 July 1964 on P-206 Atlas/Agena D (4807)
ORBIT:	177 x 220 NM at 92.9° inclination
DECAY:	3 January 1965 (6 months)
OTHER DESIGNATORS:	1964-36B, MSN-7304 (P-11 was designed as 4203 Van Allen Probe, then modified)
PAYLOAD CONTRACTOR:	ATI (Appl. Tech. Inc.), Palo Alto, Calif. ($46K)
MISSION:	ABM search, 154-550 MHz
TECHNIQUE:	Crystal video receivers 154-162 MHz, -65 dbm sens. to meas. Hen House power 169-177 MHz, -55 dbm for Tall King D/F by PRF Doppler 220-550 MHz, -65 dbm for RF (swept filter), PRF & PW
RECORDERS:	Two Prec. Instr. Co. 40 KHz 8/1 Dual Track (only non-Leach buy in P-11 history)
ANTENNA:	23 x 28 inch window shade (first deployable antenna)
72 CELL SOLAR MODULES:	50 fixed, 18 deployable (first deployable panels)
OTHER SUBSYSTEMS:	Same as 4101 Pundit I
WEIGHT:	190 lb. (incl. 34.1 lb. P/L) plus 44 lb. launcher
FAILURES:	1 day - LMSC Aux. Timer (for link turn-on in 10,040 sec) 8 days/35 cycle - both PIC recorders started sticking 38 days - Hen House receiver 102 days - One of four LMSC transmitters 126 days - Both recorders very intermittent after 350 cycles - system turned off - fairly successful
DATES:	Mission Approval: February 64 P/L Contract Award: May 64 P/L Delivery: 5 June 64 [redacted] Buy-off: 22 June 64 (L/C Copley/Capt. O'Conn[redacted] 25X1

(6) 4202 - HITCH HIKER II - VAN ALLEN BELT PROBE

LAUNCHED:	14 August 1964 on P-206 Atlas/Agena D (4808)
ORBIT:	145 x 2032 NM at 95.7° inclination
DECAY:	By January 1970, apogee had decayed to 1500 NM
OTHER DESIGNATIONS:	P-11 Radiation Satellite, 1964-45 B
SPONSOR:	Aerospace Corporation - Laboratory Division
CONFIGURATION:	Same as 4051 Hitch Hiker (230.8 lb. system/43.1 lb. payload)
FAILURES:	14 days - status commutator 22 days/359 cycle - Leach 100 KHz 12/1 recorder
OTHER:	Transponded data until turned off (day 730) Last non [redacted] P-989 system to be launched Very successful mission

25X1

DATES:		
	Mission Approval:	Fall 63
	P/L Contract Award:	Fall 63
	P/L Delivery:	May 64
	USAF Buy-off	19 June 1964

(7) 4102 - PUNDIT III - TELEMETRY SYSTEM

LAUNCHED: 8 October 1964 on P-206 Atlas/Agena D (4810)

ORBIT: No orbit - booster failed

OTHER DESIGNATIONS: MSN-7303

PAYLOAD CONTRACTOR: EDL (Sylvania), Mountain View, Calif. ($336K)

MISSION: [redacted] 25X1

CONFIGURATION: Same as 4101 Pundit II (Step through 4 crystal mixers, 500 KHz IF split through 5 x 120 Hz filters, recognizer, select, detect, and record filter output)

VEHICLE: New voltage limiter
Electrical commutator to back up mechanical

WEIGHT: 190 lb. (incl. 34.5 lb. P/L) plus 40 lb. launcher

DATES:

Mission Approval:	23 August 63
P/L Contract Award:	23 August 63
P/L Delivery:	23 January 64
[redacted] Buy-off:	17 July 64 (L/C Copley/Capt. O'Connell)

25X1

(8) 4302 - STEP 13/PLYMOUTH ROCK - ABM SYSTEM

LAUNCHED:	23 October 1964 on P-206 Atlas/Agena D (4811)
ORBIT:	172 x 191 NM at 95.4° inclination
DECAY:	23 February 1965 (4 months)
OTHER DESIGNATIONS:	1964-68B, MSNS-7305/06 (P-11 was designed as 4204 Van Allen Probe then modified)
PAYLOAD CONTRACTORS:	HRB Singer (Step 13)/ATI (Plymouth Rock) ($286K/$379K)
MISSIONS:	ABM Search 150-230 MHz and 1000-2650 MHz
STEP 13:	Superheterodyne 150-168 MHz in 48 steps, 1/2 sec. dwells 168-230 MHz in 448 steps, 6 msec dwells; sens. = -95 dbm
PLYMOUTH ROCK:	1000-2600 MHz crystal video receiver plus 10/sec swept YIG for RF; sensitivity = -65 dbm
ANTENNAS:	30 x 52 inch window shade with 150-230 MHz two-arm spiral, 1000-2600 MHz four-arm spiral
OTHER:	First flight of Adcole sun sensor and solar array power monitor Last use of single Thiokol kick rocket 50 fixed/18 deployable solar modules (like 4301)
RECORDERS:	Leach 100 KHz 1/1 (Step 13) and 4/1 (Plymouth Rock)
WEIGHT:	207 lb. (incl. 44.1 lb. P/L's) plus 44 lb. launcher
FAILURES:	41 days/360 cy - Step 13 1/1 recorder 70 days - LMSC aux. timer (for link turn-on in 10,040 sec.) 123 days - reentered with 490 cy on 4/1 recorder Fair mission success

DATES:		
	Mission Approval:	Feb. 64 (Concept Rev. 1-27-64)
	P/L Contract Award:	13 July 64 / 15 June 64
	P/L Delivery:	29 Sept. 64 / 3 Aug. 64
	[redacted] Buy-off	19 Oct. 64 (L/C Copley/Capt. O'Connell)

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(9) 4401 - PUNDIT IV - TELEMETRY SYSTEM

LAUNCHED:	28 April 1965 on P-206 Atlas/Agena D (4815)
ORBIT:	273 x 290 NM at 95.2° inclination
DECAY:	31 October 1969 (54 months)
OTHER DESIGNATIONS:	1965-31B, MSN-7309
PAYLOAD CONTRACTOR:	EDL (Sylvania), Mountain View, Calif. ($358K)
MISSION:	[redacted] 25X1
MODE B:	Video record PPM TLM as on previous Pundits
MODE A:	Step 60-80 MHz in 256 steps @ 40 msec/step Extract FDM voice by lim/descrim, encrypt at 100 KBPS, and transpond two links to Poppy stations at 138.5 and 139.5 MHz
MODE C:	Same as Mode A, but bypass encryptor and record data
ANTENNA:	30 x 52 inch windowshade
OTHER:	LMSC back-to-back kick motors for 280 NM circular orbit (first dual kick motors) Solar modules: 21 fixed, 34 deployable (4 panels) First LMSC H/S, 2nd Adcole S/S as spin axis determ. experiment
WEIGHT:	222.7 lb. (incl. 59.2 P/L) plus 44.7 lb. launcher
FAILURES:	24 days - Mode B recognizer - limited future tasking Periodic instability in H/S circuit - later redesign Periodic skipping of P/L clock - bad TI-IC - later changed to Sprague IC's Sun sensor noise pickup from command system Link degradation - turned off in 810 days - marginal system 2/1 recorder intermittent - 578 cy. 4/1 intermit - 1495 cy.
DATES:	Mission Approval: August 64 P/L Contract Award: 2 November 64 after much negot. P/L Delivery 1 March 65 [redacted] Buy-off 15 April 65 (Maj. Kulpa/Maj. Kranske) 25X1

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(10) 4402 - FANION I (EOB) / TRIPOS I (SEARCH) SYSTEMS

LAUNCHED:	25 June 1965 on P-206 Atlas/Agena D (4817)
ORBIT:	270 x 272 NM at 107.6° inclination
DECAY:	22 August 1968 (38 months)
OTHER DESIGNATIONS:	1965-50A, MSNA-7307/08
PAYLOAD CONTRACTORS:	SEL (Stanford) - Fanion, ATI - Tripos ($70K/$105K)
TRIPOS:	4000-8000 MHz spinning 3-ft. flex rib, crystal video receiver, no sidelobe inhibit
FANION:	[redacted] C, two 4-ft. trough antenna elements in mils cross configuration, crystal video receivers, YIG (10 sweeps/sec) for RF
OTHER	Fanion data successfully processed by SAC First spinning pencil beam D/F, first Aerospace [redacted] support in payload area Spacecraft ran 25°F colder than desired - LMSC thermal paint error
WEIGHT:	216.4 lb. (incl. 50 lb. P/L) plus 45.4 lb. launcher
AEROSPACE:	[redacted] evaluated SEL Fanion proposal [redacted] evaluated data processing, recommended Space Track for ephemeris, SAC for Fanion processing, identified magnetic torqueing as cause of spin axis drift
FAILURES:	Launch - Fanion antenna deployment monitor 330 days/1818 cycles - Leach 100 KHz 4/1 recorder 630 days/2422 cycles - 2nd Leach 4/1 recorder - mission terminated Fanion very successful, Tripos marginal - sidelobe pokethroughs
DATES:	Mission Approval: April 64/October 64 P/L Contract Award: August 64/November 64 P/L Delivery: May 65 [redacted] Buy-off 20 June 65 (L/C Lamb/Maj. Kranske)

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(11) 4403 - MAGNUM - ABM DIRECTED COVERAGE SYSTEM

LAUNCHED:	3 August 1965 on P-206 Atlas/Agena D (4818)
ORBIT:	270 x 274 NM at 107.4° inclination
DECAY:	17 June 1968 (31.2 months)
OTHER DESIGNATIONS:	1965-62B, MSN-7312
PAYLOAD CONTRACTOR:	ATI (Appl. Tech. Inc.), Palo Alto, Calif. ($61K)
MISSION:	ABM Search, 100-250 MHz Noah's Ark follow-on Rcvr. 1: 100-250 MHz with 145-178 MHz notch filter, crystal video rcvr. with swept YIG for RF, -90 dbm Rcvr. 2: 154-162 MHz, -80 dbm with recognizer, sample and hold to preserve Hen House rise time, 1 MHz IF at 158 MHz Rcvr. 3: 162-178 MHz or 145-161 MHz, -55 dbm
ANTENNA:	30 x 52 inch windowshade (like Pundit IV)
WEIGHT:	206 lb. (incl. 45.7 lb. P/L) plus 46 lb. launcher
FAILURES:	Antenna failed to deploy for first 16 days 142 days - multicoupler detuned causing weak links 221 days/1080 cycle - Leach 100 KHz 1/1 recorder became intermittent 265 days - Intermittent noise from H/S, S/S (RFI) 585 days - Turned off - noisy and T/R's intermittent (1/1 T/R-2459 cycle, 4/1 T/R-3362 cycle) Very successful mission - First good Hen House data

DATES:

Mission Approval:	3 Feb. 65 as modified Noah's Ark
P/L Contract Award:	12 March 65 (after 1 mo. letter contract)
P/L Delivery:	1 June 65
[redacted] Buy-off:	24 July 65 (L/C Lamb/Maj. Kranske)

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(12) 4404 LEIGE/PLICAT - DIRECTED COVERAGE SYSTEM

LAUNCHED: 14 May 1966 on P-206 Atlas-Agena D (4824)

ORBIT: 276 x 302 NM at 110° inclination

DECAY: 27 October 1970 (53.3 mos.)

OTHER DESIGNATIONS: 1966-39B, MSNA-7310/11

PAYLOAD CONTRACTOR: ATI, Palo Alto, Calif.

LEIGE: [redacted] D/F by spinning interferometer ($75K) 25X1

PLICAT: [redacted] Hen House D/F by PRF Doppler ($133K) 25X1

ANTENNAS: Orthogonal sets of two parallel 40-inch monopoles

Solar array power monitoring experiment (deployed on cables)

WEIGHT: 224 lb. (incl. 49.3 lb. P/L) plus 46.6 lb. launcher

AEROSPACE: [redacted] delivered PRF Doppler math to NSA, worked with LMSC to program PRF Doppler 25X1

FAILURES: Short circuit at first turn-on disabled recorders

Solar array experiment was evaluated before turn-off

Mission was a complete failure

DATES:

Mission Approval:	10 January 1965
P/L Contract Award:	8 Oct 65/ 20 July 65 (Leige)
P/L Delivery:	26 Jan. 66 / 12 Oct. 65
[redacted] Buy-off:	11 May 66 (Maj. Penney/Maj. Kranske)

25X1

(13) 4405 - SAMPAN I/SOUSEA I - GENERAL SEARCH SYSTEMS

LAUNCHED:	16 August 1966 on P-206 Atlas/Agena D (4829)
ORBIT:	274 x 284 NM at 93.2° inclination
DECAY:	5 March 1970 (42.6 months)
OTHER DESIGNATIONS:	1966-74B, MSNS-7314/15 (Sousea previously called North Star, Southern Cross, Blue Sea, then South Sea because of local X-band ocean surveillance interest)
PAYLOAD CONTRACTORS:	SEL (Stanford) - Sampan, ATI - Sousea
SAMPAN:	2100-4000 MHz, 3-ft. dish, crystal video receiver
SOUSEA:	8000-12000 MHz, 3-ft. dish, crystal video receiver
OTHER:	First pencil beam sidelobe inhibit/omni subsystem and pulse count subsystem First magnetic balance before launch Spin axis drift prediction software developed Switch to record sun sensor rather than H/S omitted - command limitations
WEIGHT:	267 lbs. (incl. 90.6 lb. P/L) plus 43 lb. launcher
AEROSPACE:	[redacted] evaluated Sampan proposal [redacted] evaluated new software/magnetic and dynamic balance
FAILURES:	H/S destroyed by antenna cover at launch Solar array hung up for 9 revs., deployment limit switch failed 400 days/2727 cycles - Leach 100 KHz 2/1 recorder 424 days/2878 cycles - Leach 100 KHz 2/1 recorder Killed by turning links on - one link active again in 1969 Marginal system - no D/F - work around schemes failed
DATES:	Mission Approval: Nov. 1965 P/L Contract Award: 18 Feb. 66 / 31 Jan. 66 (Sousea) P/L Delivery: 29 Apr. 66 / 31 May 66 [redacted] Buy-off 6 Aug. 66 (Maj. Penney/Maj. Kranske)

25X1

25X1

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(14) 4406 - FANION II (EOB) / TRIPOS II (SEARCH) SYSTEMS

LAUNCHED:	16 September 1966 on P-206 Atlas/Agena D (4828)
ORBIT:	251 x 269 NM at 94° inclination
DECAY:	9 May 1968 (19.8 months)
OTHER DESIGNATIONS:	1966-83B, MSNS 7317/18
PAYLOAD CONTRACTORS:	EDL (Sylvania) - Fanion II, ATI - Tripos II
FANION:	4900-5150 MHz crossed fan beam system
TRIPOS:	4000-8000 MHz 3-ft. dish pencil beam with sidelobe inhibit/main beam collection spirals on booms
OTHER:	Both systems used crystal video receivers, YIG's for RF
	First use of Leach 150 KHz recorders (upgrade of 100 KHz)
	First use of 3 sun sensors for body axes measurement
WEIGHT:	223 lbs. (incl. 50.4 lb. P/L) plus 43 lb. launcher
FAILURES:	High RFI and down link spin modulation
	150 MHz recorder sticky tape problems in test
	53 days/297 cycles - 150 KHz 4/1 recorder
	82 days/530 cycles - 150 KHz 4/1 recorder
	82 days - turned off - marginal system due to noisy links
DATES:	Mission Approval: 15 March 66
	P/L Contract Award: 5 Jan. 65 (4402 QTM)
	P/L Delivery: 15 July 66 / 6 May 65
	[redacted] Buy-off: 30 August 1966 (Maj. Penney/Maj. Kranske)

25X1

(15) 4408 - SLEWTO (DC) / FANION III (EOB) SYSTEMS

LAUNCHED:	9 May 1967 on P-846 Thorad/Agena D (1634)
ORBIT:	301 x 437 NM at 85° inclination
DECAY:	297 x 425 NM in March 1970 (long life orbit)
OTHER DESIGNATIONS:	1967-43B, MSNS-7316/19
PAYLOAD CONTRACTORS:	EDL(Sylvania) - Fanion III ESL (Electromag. Sys. Lab.) Sunnyvale - Slewto ESL is a new company - former EDL people
SLEWTO:	First pre-D system, 12 inch monopole antenna, recognizer and delay line to track Hen House RF - 154-162 MHz, parallel 600 KHz pre-D to new 1 MHz recorder and 130 KHz pre-D to 150 KHz recorder, centered to ± 50 KHz
FANION III:	(Also called Pennon) 4900-5150 MHz, 4 ft. crossed fan beam antennas, crystal video receivers with sidelobe inhibit, no omni data recorded
OTHER:	First 1 MHz recorder, EIMAC S-band transmitter, pre-D New 375 MHz 39 command system
WEIGHT:	223.9 lbs. (incl. 56.8 lb. P/L) plus 45.1 lb. launcher
FAILURES:	Bad ride to high orbit (Agena burn to depletion) 3 days - S-band transmitter lost pressure and arced over Intermittent operation of Fanion recorder 75 days - Fanion power supply 94 days - total system failure of unknown cause Success - marginal
DATES:	Mission Approval: Jan. 66 / May 66 P/L Contract Award: 27 June 66 / 3 June 66 P/L Delivery: 13 Jan. 67 / 25 Oct. 66 [redacted] Buy-off 2 May 1967 (L/C Penney/Maj. Kranske)

25X1

(16) 4409 - SAVANT I - TELEMETRY SYSTEM

LAUNCHED:	16 June 1967 on P-846 Thorad-Agena D (1633)
ORBIT:	273 x 275 NM at 80.2° inclination
DECAY:	22 October 1968 (16.2 months)
OTHER DESIGNATIONS:	1967-62B, MSN-7320, IRON-1873
PAYLOAD CONTRACTOR:	ESL (Electromag. Sys. Lab.), Sunnyvale, Calif.
MISSION:	Collect (0.5 MHz Pre-D) USSR Types B&M telemetry [redacted] 25X1
TECHNIQUE:	Step synthesizer over frequencies in priority order, cancel noise with fixed TV filters and dual tracking FM notch filters, recognize 6, 12.8, or 25.6 KBPS PPM TLM rates, lock to recognized signal and turn-on recorder
ANTENNA:	5 x 7 ft. windowshade (high drag)
OTHER:	Dual 1 MHz recorders, EIMAC transmitters (2232 & 2282 MHz) First solid spin rockets, double jointed downlink antenna boom
WEIGHT:	242.5 lbs. (incl. 54.8 lb. P/L) plus 42.5 lb. launcher
FAILURES:	Warmup problem on EIMAC 2282 MHz transmitter after 3 days (took up to 430 seconds to reach full power later in mission) 36 days - Decoder IC failed causing false command - worked around 259 days/724 cycles - 1 MHz 1/1 recorder broke tape 494 days - reentry - 2nd recorder good at 1505 cycles Recognizer had high false alarm rate Regarded as good system - led to 4419 follow-on

DATES:

Mission Approval:	July 66
P/L Contract Award:	6 Sept. 66
P/L Delivery:	7 Apr. 67
[redacted] Buy-off:	7 June 1967 (L/C Penney/Maj. Kranske) 25X1

(17) 4410 - FACADE - ABM SEARCH SYSTEM

LAUNCHED:	2 November 1967 on P-846 Thorad/Agena D (1639)
ORBIT:	250 x 280 NM at 81.7° inclination
DECAY:	28 March 1969 (16.9 months)
OTHER DESIGNATIONS:	1967-109B, MSN-7321
PAYLOAD CONTRACTOR:	EDL (Sylvania), Mountain View, Calif.
MISSION:	ABM signal search, 250-2250 MHz in two systems
TECHNIQUE:	Superheterodyne receiver, 0.1 sec/step, video recording 250-1000 MHz @ 1.25 MHz/step, 3 x 4 ft. windowshade 1000-2250 MHz @ 2 MHz/step, 6 in. conical spiral antenna
OTHER:	First 24-hour clock (EDL) - replaced 16384 second Adcole clock First ground plane fingers on VHF downlink antenna
WEIGHT:	228.4 lbs. (incl. 64.1 lb. P/L) plus 44 lb. launcher
AEROSPACE:	[redacted] statistical studies justified ABM series of P-989's for QRC, of which 4410 was the first. TMA assigned TD of PRC command software development
FAILURES:	75 days - 1000-2250 MHz power supply 97 days - 250-1000 MHz power supply 150 KHz 2/1 recorders both good at 863 cycles Used for SCF training until reentry Success was outstanding (much new ABM intelligence)

25X1

DATES:		
	Mission Approval:	January 67
	P/L Contract Award:	January 67
	P/L Delivery:	July 67
	[redacted] Buy-off:	26 October 1967 (L/C Penney/Maj. Kranske)

25X1

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(18) 4412 - TIVOLI I - ABM TI SYSTEM

LAUNCHED:	24 January 1968 on P-846 Thorad/Agena D (1638)
ORBIT:	257 x 291 NM at 81.7° inclination
DECAY:	4 March 1970 (25.3 months)
OTHER DESIGNATIONS:	1968-8B, MSN-7324, IRON-6236
PAYLOAD CONTRACTOR:	ESL (Electromag. Sys. Lab) Sunnyvale, Calif.
MISSION:	Obtain 750 KHz pre-D samples of ABM signals in the 100-4020 MHz range (for TI)
TECHNIQUE:	Step synthesizer once/4 sec. over command RF range of interest (1 or 4 MHz/step, one folded pre-D mode)
ANTENNAS:	100-520 MHz 2.5 x 5 ft. windowshade spiral 480-2020 MHz 18 inch conical spiral 1980-4020 MHz dual 6 inch conical spirals
WEIGHT:	274 lbs. (incl. 79.9 lb. P/L) plus 47 lb. launcher
FAILURES:	Warmup problem on EIMAC 2282 MHz transmitter from launch (up to 400 seconds to reach full power later in mission) Occasional spurious commands due to high receiver sensitivity 211 days/644 cycles - 1 MHz 1/1 recorder failed (stuck) 330 days - EDL system clock - Adcole command timer not affected 469 days/1067 cycles - Final 1 MHz recorder stuck (intermittent from day 247) Very successful system
DATES:	Mission Approval: January 67 P/L Contract Award: January 67 P/L Delivery: 12 Nov. 67 [redacted] Buy-off: 15 January 1968 (L/C Penney/Maj. O'Connell)

25X1

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(19) 4411 LAMPAN I / SAMPAN II - ABM SYSTEM

LAUNCHED:	14 March 1968 on P-846 Thorad/Agena D (1640)
ORBIT:	263 x 280 NM at 83.1° inclination
DECAY:	4 January 1970 (21.7 months)
OTHER DESIGNATIONS:	1968-20B, MSNS-7322/23, IRON-7076
PAYLOAD CONTRACTORS:	Lampan - ATI (Appl. Tech. Inc.), Palo Alto, Calif. Sampan - SEL (Stanford), Palo Alto, Calif.
MISSION:	Collect and locate sources of ABM signals in the 1000-4000 MHz range (Lampan = 1000-2100 MHz, Sampan = 2100-4000 MHz)
TECHNIQUE:	Spinning 6 ft. dish with two sidelobe inhibit spirals on booms, crystal video receivers with swept YIG's for RF, proportional video stretching to preserve PW
WEIGHT:	284.9 lbs. (incl. 94 lb. P/L) plus 48.6 lb. launcher
FAILURES:	Downlink antenna incompletely deployed - strong spin modulation Initial short in RO amplifier caused strong link 3 noise RT TLM VCO noisy and frequency off CMD rate reduced from 1000 to 625 PPS to get RT TLM verification 144 days/1146 cycles - 150 KHz 2/1 recorder failed 368 days/3068 cycles - Final 2/1 recorder failed Links turned on in April 1969 to kill the system, but Δ3 at 238 MHz continued active until reentry Marginal mission
DATES:	Mission Approval: January 67 P/L Contract Award: January 67 P/L Delivery: 1 November 67 [redacted] Buy-off: 6 March 1968 (L/C Penney/Maj. O'Connell)

25X1

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(20) 4420 TRIPOS III/SOUSEA II - ABM SEARCH SYSTEM

LAUNCHED:	20 June 1968 on P-846 Thorad/Agena D (1643)
ORBIT:	243 x 275 NM at 85.2° inclination
DECAY:	10 January 1970 (18.7 months)
OTHER DESIGNATIONS:	1968-52B, MSNS-7326/27, IRON-5259 (originally named Pansam/Xylene)
PAYLOAD CONTRACTOR:	AIL, Long Island
MISSION:	Collect and locate sources of ABM signals in the 4000-12,000 MHz range
TRIPOS:	4000-8000 MHz with 3 ft. dish, two omnis
SOUSEA:	8000-12,000 MHz with 1.5 ft. dish, two omnis
TECHNIQUE:	Crystal video receiver, omni sidelobe inhibit and main beam collection, proportional stretching for PW, filter bank for frequency to ± 30 MHz on each pulse
OTHER:	First P-989 for which LMSC had primary payload data processing
WEIGHT:	278.7 lbs. (incl. 97.5 lb. P/L) plus 46 lb. launcher
AEROSPACE:	[redacted] generated P/L data processing requirements for LMSC, later monitored by TMA 25X1
FAILURES:	Power control unit failed in system test - replaced by 4413 PCU Days 3-14, low solar array power 318 days - Sousea PCM subsystem (RF measurement) and TSG due to power supply failure 510 days - Transmitter 3 572 days - reentered, 4644 cycles on both 150 KHz 2/1 recorders Very successful mission
DATES:	Mission Approval: March 67 P/L Contract Award: May 67 P/L Delivery: 1 Feb. 68 [redacted] Buy-off: 11 June 1968 (L/C Penney/Maj. O'Connell) 25X1

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(21) 4413 VAMPAN - ABM SEARCH SYSTEM

LAUNCHED:	18 September 1968 on P-846 Thorad/Agena (1645)
ORBIT:	269 x 278 NM at 83.2° inclination
DECAY:	27 September 1969 (12.3 months) - very high drag
OTHER DESIGNATIONS:	1968-78B, MSN-7325, IRON-8595/2014
PAYLOAD CONTRACTOR:	EDL (Sylvania) Mountain View, Calif.
MISSION:	Collect and locate sources of ABM signals in the 100-1000 MHz range
TECHNIQUE:	Spinning interferometer with antenna pairs 100-400 MHz, 4 x 4 spirals, 0.6 MHz RF steps each spin 400-1000 MHz, spirals on 4 ft. ext., 1.2 MHz steps each spin
OTHER:	First spinning interf., second LMSC data processing
WEIGHT:	259.4 lbs. (incl. 76.9 lb. P/L), plus 46.1 lb. launcher
AEROSPACE:	Source selection reversed LMSC selection of GE, TMA provided TD of LMSC software development
FAILURES:	12 test failures - open relay coil, 10 IC's, mixer-filter Much redesign and late delivery by EDL Solar array hung up for first day 2 days - sun sensor shift register bit 5 always zero - bad solder connection 60 days - bridge circuitin payload failed - corrected in software by recalibration 375 days - reentered, 3300 cycle on 150 KHz 2/1 recorders Successful mission, [redacted] locations over 600 NM swath
DATES:	Mission Approval: January 67 P/L Contract Award: 19 June 67 P/L Delivery: 30 Aug. 68 (vs 1 March contract date) [redacted] Buy-off: 6 September 1968 (L/C Penney/Maj. O'Connell)

25X1

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4414, 4415, 4416 - NON-SP SYSTEMS

These were out-prioritied for rides by ABM series, returned to [redacted] for spare parts

4414/15: Aztecs - sponsored by Wright-Patt. Avionics Lab.
Mission: Measure space degradation of optical surfaces
Innovation: Spin axis aimed at sun and controlled

4416: Calsat - sponsored by USAF-NRD/SSD
Carried SGLS, other SCF, FPS-16, other ETR R and Ṙ equipment plus flashing light for optical tracking

Mission: Range instrumentation calibration
Data reduction software was not developed and system was stored at VAFB.

System	Approval	Delivery	Weight	
			On-Orbit	P/L
4414	12-20-65	8-14-67	263.3	69.6
4415	12-20-65	8-8-66	263.3	69.6
4416	1-27-66	12-1-67	231.9	74.6

Vehicle 4415 was used for spare parts following a stop work order on 8 Aug. 66.

Vehicle 4414 was cannibalized after 14 Dec. 67.

Calsat was taken out of storage in June 70 for display by LMSC at a space conference at Goddard and later delivered to the Air Force Museum.

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(22) 4418 - TIVOLI II - TI SYSTEM

LAUNCHED:	19 March 1969 on P-846 Thorad/Agena D (1649)
ORBIT:	269 x 280 NM at 83.1° inclination
DECAY:	6 December 1971 (32.6 mos)
OTHER DESIGNATIONS:	1969-26B, MSN-7330, IRON-2285
PAYLOAD CONTRACTOR:	ESL, Sunnyvale, Calif.
MISSION:	Obtain 750 KHz pre-D samples from 50 to 4020 MHz
DIFFERENCES FROM 4412 TIVOLI:	50-100 MHz subsystem added for [redacted] search (two monopole antennas) 25X1 Extended command capability (triple read-in)
OTHER:	First heavy P-11 (80 lbs. heavier, 50% power increase) Downlink tones used to calibrate system frequency response
WEIGHT:	333.6 lbs. (incl. 85.2 lb. P/L) plus 55.3 lb. launcher
AEROSPACE:	Provided TD of P/L mods and heavy vehicle design
FAILURES:	Power Control Unit failed in system test - unit from 4417 was substituted 7 days - LO failed causing 13% reduction in RF coverage 70 days - EIMAC S-band transmitters developed warmup problems 180 days - battery LVCO disable relay failed (no impact) 202 days/792 cycles - First 1 MHz recorder failed 400 days - limited tasking, noisy data, 1600 cycles on 2nd recorder 520 days - turned off (21 Aug. 70) Overall success regarded as good
DATES:	Mission Approval: orig. = Jan. 67, mods = 26 July 68 P/L Contract Award: Jan. 68, 2 Aug. 68 P/L Delivery: 23 Dec. 68 [redacted] Buy-off: 10 March 69 25X1 (L/C Penney, Maj. O'Connell)

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(23) 4417 LAMPAN II/SAMPAN III - GS SYSTEM

LAUNCHED:	1 May 1969 on P-846 Thorad/Agena D (1651)
ORBIT:	221 x 253 NM at 65.7° inclination
DECAY:	16 February 1970 (9.6 months)
OTHER DESIGNATIONS:	1969-41B, MSNS-7328/29, IRON-1721
PAYLOAD CONTRACTOR:	ATI, Division of ITek, Palo Alto, Calif.
MISSION:	Collect and locate (spinning 6 ft. dish) over the RF ranges Lampan: 1000-2100 MHz Sampan: 2100-4000 MHz
DIFFERENCES FROM 4411 LAMPAN/SAMPAN:	1200-1470 MHz CW microwave search subsystem added Stanford box to dump all PRF's of 374 in Sampan Payload PCM frequency and PW rather than swept YIG/VCO's Heavy P-11 with dual battery system
WEIGHT:	364.7 lbs. (incl. 110.4 lb. P/L) plus 54.6 lb. launcher SP-7 criticism for exceeding 400 lb. max. weight (419.3 lb.)
FAILURES:	Two Horizon Sensors failed in system test One launcher spring stuck causing 20° spin axis error Strong 100 pps noise from CW subsystem in Sampan data 56 days - EDL system clock failed 200 days - Noticeable speed variation on one recorder 291 days - Reentered, 2308 cycles on both 150 KHz 2/1 recorders - fairly successful mission
DATES:	Mission Approval: Orig. = Jan. 67, mods = 1 Sept. 68 P/L Contract Award: Jan. 68, Sept. 68 P/L Delivery: 2 Jan. 69 [redacted] Buy-off: 4-25-69 (L/C Penney/Maj. O'Connell)

25X1

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(24) 4419 - SAVANT II - TELEMETRY SYSTEM

LAUNCHED: 22 September 1969 on P-846 Thorad/Agena D (1653)

ORBIT: 262 x 271 NM at 85.17° inclination

DECAY: 16 May 1971 (19.8 months)

OTHER DESIGNATIONS: 1969-79B, MSN-7336, IRON-4710

PAYLOAD CONTRACTOR: ESL (Electromag. Syst. Lab.), Sunnyvale, Calif.

MISSION: [redacted] 25X1

DIFFERENCES FROM 4409 SAVANT: 3 frequencies added, 3 foot monopole antenna used for 4 lower frequencies, 5 x 7 foot windowshade spiral for 6 higher frequencies, improved recognizer and payload status telemetry, RT status telemetry transmitted at both VHF and S-band

Heavy P-11 with dual power system, 3 recorders

WEIGHT: 318.2 lbs. (incl. 62.1 lb. payload) plus 51.5 lb. launcher

AEROSPACE: [redacted] attributed Savant II approval to [redacted] Memo BIF-107-440071-68 on telemetry sampling 25X1

FAILURES: Launch to 35 days - 2232.5 MHz transmitter completely degraded (EIMAC design - bought out by Walkins-Johnson)

7 days - Link switch or connector to north antenna

70 days - Payload clock failed removing clocking tone from tape, remaining transmitter getting noisier

191 days - Horizon sensor failed

420 days/435 - 1 MHz recorder failed (one of three)

595 days - Turned off with 1630 cycles on second 1 MHz recorder, 1371 on the other - fairly successful mission

DATES:

Mission Approval:	23 Dec. 68 (mod. 4409 QTM)
P/L Contract Award:	1 Jan. 69
P/L Delivery:	1 June 69
[redacted] Buy-off:	9-5-69 (L/C Penney/Maj. O'Connell)

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(25) 4407 - WESTON - COMINT COPY SYSTEM

LAUNCHED:	30 September 1969 on P-770 Thorad/Agena D (2706 Poppy)
ORBIT:	247 x 266 NM at 69.6° inclination
DECAY:	30 October 1970 (13 mos.)
OTHER DESIGNATIONS:	1969 - 82A, MSN - 7313, IRON-1807
PAYLOAD CONTRACTOR:	HRB-Singer, State College, Penn.
MISSION:	Collect and encrypt (200 KBPS) video samples of [redacted] voice signals in the 60-70 MHz and 360-420 MHz ranges
ANTENNAS:	60-70 MHz 2.5 x 3 foot flat spiral windowshade 360-420 MHz 2 ft. log periodic (oil derrick)
TECHNIQUE:	Stepped superheterodyne receiver with -110 dbm sensitivity Limiter discriminator on 40 KHz IF passband Recognize 300 or 500 Hz tones, teletype, and/or two channel baseband voice energy spectrum to lock receiver Count cycles at 21.4 MHz IF for precision RF
WEIGHT:	248.2 lbs. (incl. 73.9 lb. payload) plus 45.5 lb. launcher
OTHER:	Long painful development - then ABM series forced two year delay in ride
FAILURES:	50 days - instability in horizon sensor circuit 118 days/571 cycles - 150 KHz 2/1 recorder 200 days - battery very sick - tasked once per day 286 days - final recorder sticking 321 days - power system purposely killed (17 Aug.) Overall success regarded as fair
DATES:	Mission Approval: April 65 P/L Contract Award: 2 Aug. 65/5 Sept. 68 (mods) P/L Delivery: July 67/Dec. 68 [redacted] Buy-off: 25 June 68/5 Sept. 69 (L/C Penney/Maj. O'Connell)

25X1

25X1

(26) 4422 - TIVOLI III - TI SYSTEM

LAUNCHED:	4 March 1970 on P-846 Thorad/Agena D (1656)
ORBIT:	248 x 278 NM at 88.14° inclination
DECAY:	10 November 1971 (20.2 mos.)
OTHER DESIGNATIONS:	1970 - 16B, MSN-7335, IRON-3402
PAYLOAD CONTRACTOR:	ESL, Sunnyvale, Calif. ($0.82M)
MISSION:	Obtain 750 KHz pre-D samples from 50 to 4020 MHz
DIFFERENCES FROM 4418 TIVOLI:	290 MHz main beam intercept system added Used magnetic spin axis torqueing as test of technique for 4427 Arroyo First solar array disconnect system for positive silencing of disabled birds (see 4411/4405 failure notes)
WEIGHT:	343.45 lbs. (incl. 79 lb. P/L) plus 51.8 lb. launcher
AEROSPACE:	Recommended spin axis torqueing test Determined cause of WJ transmitter warmup problem Identified link problem as multicoupler arcing
FAILURES:	Day 3-103 - Bad track on recorder No. 2 (recovered) Days 5-60 - Bad links - multicoupler arcing 38 days - Recorder No. 3 blew fuse (failed after 121 cycles) 96 days - more arcing - cured by spin axis torqueing to cool S/C 160 days - 2232.5 MHz WJ transmitter got noisy 577 days (2 Oct. 71) - Turned off with 3884 cycles on remaining 1 MHz recorder Fairly successful mission
DATES:	Mission Approval: 10 Dec. 68 P/L Contract Award: 28 Mar. 69 P/L Delivery: 12 Nov. 69 [redacted] Buy-off 6 Feb. 70 (L/C Penney/Maj. O'Connell)

25X1

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(27) 4421 - TRIPOS IV/SOUSEA III - GS SYSTEM

LAUNCHED:	20 May 1970 on P-846 Thorad/Agena D (1657)
ORBIT:	261 x 275 NM at 83.11° inclination
DECAY:	227 NM spinning at 7 rpm (vs initial 55 rpm) by 10-1-72
OTHER DESIGNATIONS:	1970-40B, MSNS-7332/33, IRON-8520
PAYLOAD CONTRACTOR:	AIL, Long Island, NY ($1.43M)
MISSION:	Collect and locate sources of pulsed and CW signals
TRIPOS:	4000-8000 MHz with 3 ft. dish, two omnis
SOUSEA:	8000-12000 MHz with 1.5 ft. dish, two omnis
DIFFERENCES FROM 4420 TRIPOS/SOUSEA:	Swept filter added for CW. Three 1 MHz recorders with 250 KBPS (freq., PW, and PA) PCM at 2/1 slowdown. S-band downlinks
WEIGHT:	333.3 lbs. (incl. 86 lb. P/L) plus 52.4 lb. launcher
AEROSPACE:	Specified CW mode, PCM approach, and beam sharpening on Tripos antenna (using spiral difference mode)
FAILURES:	Recorders leaked and blew fuses in test
	Sprayed with oil in vacuum test
	Has 38 bad lot Fairchild IC's in P/L (as did 4420)
	Day zero - 1 of 3 sun sensors out
	27 days - blew fuse on one recorder (61 cycles)
	61 days - Relay in PCU hung up, no trickle charge
	264 days - WJ transmitter got too noisy to use
	293 days - 2nd 1 MHz recorder stuck after 1055 cycles
	850 days - still being tasked several times per day with noisy transmitters and one recorder (over 2400 cycles) Fairly successful mission.
DATES:	Mission Approval: 10 Dec. 68
	P/L Contract Award: 6 Feb. 69
	P/L Delivery: 24 Feb. 70
	[redacted] Buy-off : 8 May 70 (Col. Penney/Maj. O'Connell)

25X1

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(28) 4423 - TOPHAT I - COMINT SYSTEM

LAUNCHED:	18 November 1970 on P-846 Thorad/Agena (1659)
ORBIT:	261 x 276 NM at 83° inclination
DECAY:	251 NM, 23 rpm by 10-1-72
OTHER DESIGNATIONS:	MSN-7334, IRON-6829, 1970-98B
PAYLOAD CONTRACTOR:	LTV, Garland, Texas ($2.79M)
MISSION:	Map and copy troposcatter links and beams over the 450-1000 MHz range
CONFIGURATION:	Spinning interferometer with back-to-back pairs of conical spiral antennas (first pneumatic deployment), breakout and record selected 12 voice channels plus tones and teletype, 1 MBPS encrypt on playback with second recorder track on 1.7 MHz VCO, fast RF search with recognition signal lock-on. Mapping data is 32 KBPS PCM.
RECORDERS:	Three back-to-back 150 KHz 1/1 recorders
WEIGHT:	341.1 lbs. (incl. 75.7 lb. P/L) plus 51.3 lb. launcher
AEROSPACE:	Sold concept and helped specify the configurations
OTHER:	Greatest P/L delivery slip since 4413 (originally scheduled for February 1970) Original encryption rate was 1.5 MBPS, but SCF can only handle up to 1.024 MBPS First use of Conic transmitter to back up Watkins-Johnson
FAILURES:	None after 22 months on orbit - Most healthy P-989 system in program history Spurious commands (no mission impact) Very successful mission
DATES:	Mission Approval: 10 Dec. 68 P/L Contract Award: 10 Mar. 69 P/L Delivery: Early Aug. 70 [redacted]Buy-off: Oct. 70 (L/C Jakes/Maj. Rudolph)

25X1

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(29) 4427 - ARROYO - COMINT MAPPING SYSTEM

LAUNCHED:	10 September 1971 on P-846 Thorad/Agena (1662)
ORBIT:	266 x 274 NM at 75.1° inclination
DECAY:	
OTHER DESIGNATIONS:	MSN-7337, IRON-7681, 1971-76B
ARROYO:	
PAYLOAD CONTRACTOR:	AIL, Long Island, NY ($2.84M)
MISSION:	Map to [redacted] 95% confidence, microwave towers over the 1200-2200 MHz and 3400-3900 MHz ranges
CONFIGURATION:	Spinning 6 ft. dish with beam split feed down spin axis for con scan, spin axis torqueing, phase measuring payload, fast RF search with recognition lock-on, pairs of sidelobe inhibit antennas for interferometer main beam D/F, precision ERP and RF measurements
RECORDERS:	Two back-to-back 150 KHz 4/1 recorders
WEIGHT:	362 lbs. (incl. 78.4 lb. P/L) plus 55 lb. launcher
AEROSPACE:	Sold concept and helped specify configuration 25X1
OTHER:	First spacecraft with spin rate control First system with steady PCM format. First satellite in SCF net with more than 10,000 separate commands (13,344) Originally mated with March P-846 ride - launcher stayed on
FAILURES:	Payload malfunction in Feb. 71 test at VAFB - many workmanship deficiencies 30 days - complete failure of payload (phase-lock loop) 355 days, balance boom separated causing 90° spin axis shift in body coordinates 360 days, sun sensor shift register failed System did not map to better than [redacted] accuracy (no bias analysis done) but there is interest in a follow-on
DATES:	Mission Approval: 30 June 69 P/L Contract Award: 15 Sept. 69 P/L Delivery: 31 Oct. 70 [redacted] Buy-off: 5 Aug. 71 (L/C Wippermann/Capt. Bryson)

~~SECRET/E~~

(30) 4425 - MABELI - ABM MAIN BEAM TI SYSTEM

LAUNCHED:	20 January 1972 on P-467 Titan III-D (SV-2)
ORBIT:	254 x 299 NM at 96.5° inclination
DECAY:	271 NM, 40 rpm by 10-1-72
OTHER DESIGNATIONS:	MSN-7339, IRON-7719, 1972-002D
MABELI:	MAin BEam tivoLI (first acronym)
PAYLOAD CONTRACTOR:	ESL, Sunnyvale, Calif. ($3.9M)
MISSION:	Track frequency and measure ERP to +0.5 db plus polarization on Hen House [redacted] Dog House (387-426 MHz), Big Screen (862-964 MHz), and Try Add (1500-2500 MHz) 25X1
CONFIGURATION:	Flat spiral with two RHC and two LHC windings for Hen House, separate RHC and LHC conical spirals for others, compare power and phase for polarization ellipse, delay line technique for frequency tracking, pre-D for fine frequency/coding, spin axis control (on all P-467 launches)
RECORDERS:	Three back-to-back 1 MHz recorders at either 1/1 or 4/1 ratio (first dual speed ratio recorders)
DATA:	Steady 200 KBPS PCM (incl. clock and attitude data) plug analog
WEIGHT:	380 lbs. (incl. 93 lb. P/L) plus 55 lb. launcher
AEROSPACE:	Sold concept and helped specify configuration
FAILURES:	0 day - Limit switches failed to indicate deployment of one solar array, antenna, balance boom Dog House antenna problem - up to 4 db discrepancy in ERP measurements 72 days - Pre-D subsystem failure reduced coverage of Try Add band by 12% including small Try Add frequency 180 days - Both WJ transmitters very noisy - 2 conics OK Healthy system, but customer interest in data appears low
DATES:	Mission Approval: 3 April 70 P/L Contract Award: 16 Apr. 70 P/L Delivery: 23 Feb. 71 [redacted] Buy-off: 5 Nov. 71 25X1 (L/C Wippermann/Capt. Bryson)

~~SECRET/E~~

(31) 4425 - URSALA-I - EOB/GS SYSTEM

LAUNCHED:	7 July 1972 on P-467 Titan III-D (SV-3)
ORBIT:	266 x 273 NM at 96.4° inclination
DECAY:	267 NM, 56 rpm by 10-1-72
OTHER DESIGNATIONS:	MSN-7338, IRON-7803, 1972-052C
URSALA:	Universal Radar Search And Location Acquisition
PAYLOAD CONTRACTOR:	Motorola, Scottsdale, Ariz. ($3.5M for first unit)
MISSION:	Collect and locate sources of pulsed signals to [redacted] CW signals to [redacted] over the 2000-12000 MHz frequency range
CONFIGURATION:	Spinning pencil beam with 3 ft. (2000-8000 MHz) and 6 ft. (4000-12000 MHz) antennas, pulse by pulse D/F with multimode flat spiral feed, filter bank for 3 RF's per pulse, swept filter and centroiding for CW, RF to ± 18 MHz, command 2000 MHz at a time, 245 KBPS all PCM data format for digital processibility, three back-to-back 1 MHz 4/1 recorders. Spin rate control to 55 ± 1 rpm to preserve validity of bias analysis.
WEIGHT:	390.9 lbs. (incl. 104.6 lb. P/L) plus 54.4 lb. launcher (In the Motorola proposal, the P/L weight was 69 lbs.)
AEROSPACE:	Helped sell concept, specify configuration, and identify corrective action for the many development problems.
OTHER:	Greatest P/L delivery slip in program history (10 mos.) Bad lot of TI SNR 54L IC's - 6 failures during payload test span First of a new series of EOB systems
DATES:	Mission Approval: 27 Feb. 70 P/L Contract Award: 4 May 70 P/L Delivery: 1 Feb. 72 (vs 5 Apr. 71 contract date) [redacted] Buy-off: 24 May 72 (L/C Wippermann/Capt. Bryson)

25X1

25X1

~~SECRET/E~~

(32) 4426 - URSALA-II - EOB/GS SYSTEM

LAUNCH:	Scheduled for April 1973 on P-467 Titan III-D (SV-5)
OTHER DESIGNATIONS:	MSN-7342, IRON-7705
PAYLOAD CONTRACTOR:	Motorola, Scottsdale, Ariz. ($2.7M)
MISSION:	Collect and locate sources of pulsed signals to [redacted] CW signals to [redacted] over the 2000-12000 MHz frequency range 25X1 25X1
DIFFERENCES FROM 4425 URSALA:	Essentially none - built in parallel and had same 10 month P/L delivery schedule slip
WEIGHT:	391 lbs. (incl. 104.6 lb P/L) plus 55 lb. launcher
AEROSPACE:	Helped sell concept, specify configuration, and identify corrective action for development problems
OTHER:	Bad lot of TI SNR 54L IC's - 2 failures in payload test at Motorola

DATES:

Mission Approval:	27 Feb. 70
P/L Contract Award:	4 May 70
P/L Delivery:	26 June 72
[redacted] Buy-off:	Feb. 73 (L/C Wippermann/Capt. Bryson) 25X1

(33) 4428 - TOPHAT-II - COMINT SYSTEM

LAUNCH:	Scheduled for January 1974 on P-467 Titan III-D (SV-7)
OTHER DESIGNATIONS:	MSN-7340, IRON-6935
PAYLOAD CONTRACTOR:	E-Systems (LTV), Garland, Texas ($2.2M)
MISSION:	Map to [redacted] and copy troposcatter links and other CW emitters over the 450-1000 MHz range
DIFFERENCES FROM 4423 TOPHAT:	Main beam mapping mode was dropped and a fixed tuned receiver channel was added to increase probability of map and copy of a high priority short on-time signal.
WEIGHT:	350 lbs. (incl. 80 lb. P/L) plus 55 lb. launcher
OTHER:	Success of Tophat-I resulted in easy approval of Tophat-II Last P-989 system of current design (375 MHz command link, non-SGLS, current structure, and rocket motors)

25X1

DATES:		
	Mission Approval:	Aug. 71
	P/L Contract Award:	Oct. 71
	P/L Delivery:	May 73
	[redacted] Buy-off:	Oct. 73

25X1

(34) 4430 - URSALA-III - EOB/GS SYSTEM

LAUNCH: Scheduled for January 1974 on P-467 Titan III-D (SV-7)

OTHER DESIGNATIONS: MSN-7343, IRON-6239

PAYLOAD CONTRACTOR: Motorola, Scottsdale, Ariz. ($3.2M)

MISSION: Collect and locate sources of pulsed signals to [redacted] CW signals to [redacted] over the 2000-12000 MHz frequency range. 25X1

DIFFERENCES FROM 4425/26 URSALAS: First of a new series of heavy P-989 systems with larger rocket motors, greater solar array area, new power control, SGLS (cmd, range, and PCM TLM), and larger volume

P/L improvements include elimination of RF overlap between antennas, several db sensitivity improvement, and improved RF resolution (from 32 MHz to 5 MHz)

For reliability the 1 MHz recorders will be replaced by 150 KHz recorders. The P/L buffer storage will be increased from 64 to 512 pulses to accommodate a 245 to 32 KBPS recording rate reduction. Onboard data rate control.

WEIGHT: 533 lbs. (incl. 150 lb. P/L) plus 57 lb. launcher

OTHER: The larger rocket motors will permit several degrees plane change from the P-467 sun synchronous orbit and thus establish sufficient orbital plane precession to prevent the grouping of future P-989 spacecraft in a common orbital plane.

DATES:

Mission Approval:	28 Feb. 72
P/L Contract Award:	May 72
P/L Delivery:	June 73
[redacted] Buy-off:	Nov. 73

25X1

(35) 4429 - RAQUEL - GS/TI SYSTEM

LAUNCH: Scheduled for April 1974 on P-467 Titan III-D (SV-8)

OTHER DESIGNATIONS: MSN-7341, IRON-6239

RAQUEL: Radar AcQUisition Equipment with Location

PAYLOAD CONTRACTOR: E-2 Systems (LTV), Garland, Texas ($3.2M)

MISSION: Collect and locate sources of pulsed and CW signals to [redacted] accuracy over the 4000-18000 MHz frequency range 25X1

Obtain 750 KHz pre-D samples of CW signals

CONFIGURATION: Spinning pencil beams using a 3 ft. unfurled parabola for 4-8 GHz, a 3 ft. solid parabola for 8-12 GHz, and a 2 ft. solid parabola for 12-18 GHz. A filter bank is used to measure pulse frequency to ± 30 MHz within 2000 MHz commanded at any given time. The pulse frequency system can be switched to either the DF or the omni antennas. 256 KBPS for EOB/GS on one track (4:1 or 1:1 mode), 750 KHz pre-D on second track (1:1 mode). CW inhibit is provided for unambiguous DF. Compressive filter for 13 MHz pre-D or Comint baseband copy.

WEIGHT: 540 lbs. (incl. 135 lb. P/L) plus 57 lb. launcher

AEROSPACE: Helped sell concept, specify configuration, and provide careful monitoring of system development

OTHER: Spin axis will be controlled at angle of 35° off North. Spin rate controlled to 55 rpm. Correlation of main beam and sidelobe intercept data is planned.

DATES:

Mission Approval:	Oct. 71
P/L Contract Award:	15 Mar. 72 (signed 3 May 72)
P/L Delivery:	15 Aug. 73
[redacted] Buy-off:	Jan. 74

25X1

(36) 4431 - URSALA-IV - EOB/GS SYSTEM

LAUNCH: Scheduled for January 1975 on P-467 Titan III-D (SV-10)

OTHER DESIGNATIONS: MSN-7344, IRON-

PAYLOAD CONTRACTOR: Motorola, Scottsdale, Ariz. ($3.2M)

MISSION: Collect and locate sources of pulsed signals to [redacted] CW signals to [redacted] over the 2000-12000 MHz frequency range 25X1

DIFFERENCES FROM 4430 URSALA: None - built-in parallel

WEIGHT: 543 lbs. (incl. 135 lb. P/L) plus 57 lb. launcher

OTHER:

DATES:

Mission Approval:	28 Feb. 72
P/L Contract Award:	May 72
P/L Delivery:	Nov. 73
[redacted] Buy-off:	Nov. 74

25X1

PROMISING NEW CONCEPT

SHARON:	Signal Handling And RecognitiON
MISSION:	Collect, locate, copy, and identify Comint and Telint signals in the 60-450 MHz frequency range
CONFIGURATION:	Spinning interferometer with pair of 4' x 4' flat spirals for 60-200 MHz, pair of conical spirals for 200-450 MHz, multiple signal recognition criteria, 1 MHz recorders for telemetry or communications signal baseband copy, encrypt Comint on playback.
MAJOR PROBLEMS:	Routine AM/FM interference and multitude of recognition parameters
POSSIBLE SOLUTION:	Use minicomputer to program recognition criteria on per signal basis and supply it with A/D converted spectral analysis to generate PCM road map for identification of signals of interest by the analyst based on location and spectrum
AEROSPACE:	Originated and presented concept
STATUS:	Presented to NRO/NSA in May 1971 Subject for early October 1972 meeting at NSA
OTHER:	Meeting at NSA will also cover priorities, other candidate P-989 missions (i.e., another Arroyo microwave mapper), and possible add-on payloads which remain with the P-467 vehicle