The Database of Cost References by Groups – PDF#5

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GROUND RADAR

GR1 – NADGE -- NATO Air Defense Ground Environment System

Cost -- $ 60 million a year for operations and maintenance
Discussion –
Source – Common Funding in NATO, RAND RM-5282-PR, June 1967, p 59.
Recorded – September 5, 1968

GR2 – Earth Station – for Apollo

Cost -- $1.5 million each
Discussion – COMSAT has a contract with Page Comm. Engineers, Inc. here to furnish 3 self-contained portable earth stations for $4,512,772 or about $1.5 million each.
These will be located at each of the initial 3 U.S. stations. They will be used to supply the communication needs of the Apollo program
Source – Electronic News, February 14, 1966.
Recorded – February 22, 1966.

GR3 – Radar Antennas

Costs – as follows
Discussion –

Diameter	Mount	Approx. Cost	Approx. Weight	No. Built to Date
Ft.		$	$	7-20-61
60	Ag-El	275,000	80,000	24
60	Ha-Dec	275,000	80,000	1
84	Ag-El	450,000	97,000	4
84	Ha-Dec	450,000	97,000	7

Note: Costs are exclusive of foundation, transportation, and special service towers and wave guides but including power drive. Service servos, data

D. J. Kennedy Co. Antennas

Customer	Dia.	Mount	Antenna Site	Remarks	Cog. Person
MIT Lab	60	Ag-El	S. Dartmouth	1 only	L. Coreys
	60		Wallops Isl, Va	3 ea. On 5 in. gun mounts	
	84		W. Ford, Ms	Ref only	

	84		Trinidad		
Nav Res Lab,	84		Canada		
Wash DC	60		Japan	Sp Mount	R A Carpenter
Army Belmar, NJ	60		Belmar		
STL	60		S. Pt., Hawaii	Bendix Operated	

equipment, etc., are extra.
Source – Ground Equipment for Satellite Comm., Walter K. Victor, JPL Tech. Report No. 32-137, August 1, 1961, p 51
Recorded – January 10, 1966.

GR4 – Austere Ground Station – for Com. Sat.
Cost – as follows
Discussion – Austere Grd. St. Major Component Req. & Costs

Major Eq. Item	Feeder Station	Major Com. Cost – Relay Stations	Major Com Cost – Relay Stations	Major Com Cost – Relay Stations	Major Com Cost – Relay Stations
Anetennas 20ft	2				
60 fit		3	4	5	6
Receivers	2	3	4	5	6
Transmitters	2	3	4	5	6
Satellite Acq	1	1	1	1	1
Display & alignm.	1	1	1	1	1
Timing & orbit data	1	1	1	1	1
Microwave	1	1	1	1	1
Vans	2 or 3				

Costs ($millions)

Investment	1.60	3.53	4.54	5.55	6.56
Annual Ops	.40	.88	1.14	1.39	1.64
Level annual cost	.59	1.29	1.66	2.03	2.40

Source – Des. & Use of am Early Com. Sat. System, RAND RM-3514-NASA, July 1963, p 91.
Recorded – January 12, 1966

GR5 – Ground Station

Cost -- $2 million to $8 million
Discussion – depending upon a number of technical considerations, such as whether the ground antenna must be able to search for a roving satellite or whether it need only focus on a stationary satellite, whether dual installations are require, etc.
Source – Communications Satellite Technical, Economic Development, Staff Report Committee on Aero. & Space Science, US Senate, 87th Congress, 2nd Session, February 25, 1962, p 117
Recorded – February 21, 1966.

GR6 – Simple Antenna for a Synchronous Satellite
Cost -- $500,000
Discussion – with the complete terminal costing $2 and ½ million
Source – Missiles & Rockets, January 31, 1966, p 41.
Recorded – February 14, 1966.

GR7 – Hughes Built AN/MSC-46
Cost – 8 for $12 million, R&D and Procurement program
Discussion – 40 ft. semi-fixed but transportable terminal housed in 3 vans, plus additional power equipment.
The first two systems have been delivered.
The first unit is being used for training purposes, but the other units are expected to be deployed outside the US.
Source – Missile & Rockets, January 31, 1966, p 63.
Recorded – February 15, 1966.

GR8 – Four-bay Yagi Antenna plus Pre-Amplifier
Cost -- $50 - $75
Discussion --The four bay Yogi would give a gain of 20 db, with another 15 db provided by a low-noise transistor pre-amplifier. The combination should cost $50 – 75, depending on production quantities, according to John Mahler who headed the RCA satellite study.
Source – Aviation Week, January 10, 1966, p 117.
Recorded – January 31, 1966.

GR9 – Radar Modification for Sea-Launched Ballistic Missile Defense
Cost -- $10.5 million for 7 FBS-26 radars
Discussion – Modify an existing Semi-Automatic Ground Environment (SAGE) Air-defense radar to fulfill the SLBM warning role.
Mode. An AN/FPS-26 normally used as a height-finder in conjunction with the SAGE/Back-Up Interceptor Control System (BUIC)
Done by Avco Corp’s Electronics Div. in Cincinnati.
An additional award to Avco, probably slightly in excess of $12 million, is expected prior to program completion.
Major changes include a “slight” increase in transmitted power to achieve greater range (at least several hundred miles beyond the 220 n mi figure, a decrease in the

radar's pulse repetition frequency to compensate for the longer individual pulse travel time to and from the target, and a reshaping of the radar's antenna to reflect the changed gain and pattern requirements.
Source – Missiles & Rockets, January 24, 1966, p 16.

Recorded – February 9, 1966.

GR10 – STADAN Tracking Network
Cost -- $20 million NASA contract
Discussion – Maintenance, operation, and logistic support
Bendix Field Engineering Corp.
For support of portions of world wide STADAN
Source – Space Age News, November 1963, p 10.
Recorded – March 16, 1964.

GR11 – Project Red Mill – ICBM Launch Detection System
Cost -- $3.7 million
Discussion – Air Force Contract (see Aviation Week, October 7, 1963, p 30.
Built by Raytheon
Extend coverage now available from BMEWS
Source – Aviation Week, October 14, 1963, p 23
Recorded – January 28, 1964.

GR12 – 210 ft Antenna
Cost -- $12 million development
Discussion – for NASA deep space facilities
New antenna will expand the communications capability of the NASA/JPL deep space instrumentation facility by providing 6.5 times more transmitting power and a like receiving sensitivity increase over the 85 ft antennas now in use.
Source – Space Age News, February 1964, p 15
Recorded – May 15, 1964.

GR13 – 85 ft Antenna
Cost -- $5 - 6 million
Discussion – Seamans – already located at Goldstone, Calif., Australia, Johannesburg.
Antenna is mounted on a special trunnion so it can track through the zenith, track through the complete hemisphere over that particular site.
In addition, there has to be the electronic equipment that serves to transmit and receive information from the antenna, and communications equipment to tie to telephone network to JPL.
Source – Senate Aeron. & Space Sciences Com. Hearings, 88th Congress, 1st Session, Part I p 153.
Recorded – November 5, 1963.

GR14 – 84 ft. Parabola Receiver Antenna (or 50 ft. horn)

Cost -- $.75 million for investment
Discussion – for ground terminal -- low altitude system
Source – RAND RM-2778-NASA, Comm. Satel. Supplemental Information on the Cost Estimate Given Res. Mem, RM-2709-NASA, Meckling, June 30, 1961, p 11.
Recorded – February 4, 1964.

GR15 – 1000 ft Antenna, Arecibo Ionospheric Observatory
Cost -- $8.3 million
Discussion – in Puerto Rico
40,000 times more powerful than Millstone hill radar which first make contact with Venus
Just dedicated, it utilizes 2 10 fit long 2.5 million-watts klystrons by Varian Associates, and a radar transmitter by Energy Systems, Inc., both of Palo Alto, Calif.
Aricibo may achieve first contact with Jupiter, 3000 mil miles distant.
Source – Space Age News, November 1963, p 10
Recorded – March 16, 1964

GR16 – Ground Station Costs
Cost – as follows in million of dollars
Antenna Size (diameter in feet)

Fixed Station Type	85 (f)	60 (f)	40 (f)	30 (f)
Tracking Ant.	4.0	3.2	2.6	2.4
Fixed Ant.	3.6	2.9	2.3	2.0
Transportable Station Type	40 (T)	30 (T)	15 (T)	6 (T)
Tracking Ant.	2.2	1.6	0.89	0.64
Fixed Ant. *	1.9	1.3	0.80	0.62

- Capable of being repositioned but non-tracking

(f) Fixed Station
(T) Transportable Station

For multiple antenna configurations multiply the additional number of antennas required by the following appropriate factor and add to the initial value of table 1 (see Initial Launch Vehicle Cost)

Multiple Antenna Incremental Cost
Antenna Size (Diameter in feet)

Ant./St Type	85 (F)	60 (F)	40 (F)	40 (F)	30 (F)	30 (F)	15 (F)	6 (F)
Tracking Ant.	2.1	1.8	1.5	1.2	1.4	1.1	.70	.54
Fixed	1.9	1.6	1.3	1.0	1.2	.97	.66	.51

Ant.								

Source – DCA – Standard Cost Data for ADCSP Def. Study, January 28, 1965, p 15
Recorded – February 3, 1965.

GR17 – Satellite Tracking – Satellite missile tracking observatory
Cost -- $5 million
Discussion – University of Mich. won ARPA contract to build
On Mt Haleakala on the Island of Maui, Hawaii
Will have a 60 in reflector and 2 48 inch telescopes
Source – Aviation Week, December 21, 1964, p 13.
Recorded – January 27, 1965.

GR18 – LEM Radar -- Rendezvous-radar system for LEM
Cost – Total funding to date $585 million, including some $16.8 million required to complete.
Discussion – RCA began development under a $23.5 million contract from Grumman in November 1963. Feasibility studies had led to selection of a phase modulated continuous-wave cooperative system operating in the X-band.
LEM Rend. Radar Performance
Range – 80 ft to 400 n mi (min.)
Range accuracy – 0.25% for 5-400 n mi
1.0% for 600 ft – 5 n mi, and 200 – 400 n mi.
Source – Technology Week, July 1, 1966, p 30
Recorded – August 8, 1966.

GR19 – LEM Rendezvous Radar
Cost -- $23.5 million development
Discussion – RCA began development
Contract to Grumman in November, 1963.
Feasibility studies had led to selection of a phase-modulated, continuous-wave cooperative system operating in the X-band.
Total funding to date is $59.5 million including some $16.8 million required to complete the program.
Range 80 ft – 400 n mi (min)
2 ft dish
(In November 1963, at NASA's request, Westinghouse developer of the GEMINI radar submitted a proposal for building and delivering 25 LEM radars in 23 months at a fixed price of $16.6 million).
Source – Technology Week, July 11, 1966, p 30
Recorded – August 22, 1966.

GR20 – DSIF – NASA's Deep Space Tracking Network
Cost – Operations and Maintenance -- about $8 million per year

Discussion – six firms are competing for the award.
Source – Technology Week, August 1, 1966. p 18
Recorded – August 25, 1966.

GR21 – AN/PPS-5, Army's new Portable Short Range Surveillance Radar Set
Cost – total contract value is expected to exceed $4 million for delivery of 125 units plus spares.
Discussion – to Airborne Instruments Lab. Div. of Cutler-Hammer, Inc.
For tactical field area surveillance of a broad perimeter with a range of at least 5,000 meters against personnel and up to 10,000 meters for detection of vehicles.
Weighs 56 lbs and requires only 24 watts of power.
Will eventually replace AN/PPS-4
Source – Technology Week, August 1, 1966, p 39.
August 25, 1966.

GR22 – Antenna Feed on Apollo Instrumentation Ships
Cost -- $570,000 development subcontract with General Dynamics
Discussion – Developed by Sylvania
Will permit the 30 ft dishes to track out to synchronous distances (22,300 mi) to an accuracy of 0.04 degrees.
General Dynamics prime contractor for conversion of the 3 tankers.
New feed includes one transmitting and four receiving elements.
Source – Technology Week, August 15, 1966, p 4
Recorded – September 12, 1966.

GR23 – MAR, Nike X, Multifunction Array Radars
Cost – Tactical version costs more than $250 million per copy. (TACMAR)
Discussion – Full-scale MAR cost is estimated at more than $400 million a piece.
Recorded – December 1, 1966,

GR24 – Midas Tracking Sites
Cost -- $3,121,330 for construction

Discussion --	Central Operations & System Cont. Bldg (1 req)	$2,489,170
	Satellite Comm. Blg (3 req)	346,860
	Antenna Support Structure (3 req)	91,500
	Radome Support Structure (3 req)	193,800

Does no include costs for site preparation, roads, parking areas, security fence, and check houses, exterior utilities distribution systems and utility buildings, grading, drainage, power generation plant, master distribution substation, or conduit systems for instrumentation and communication cabling.
Source – Midas Tracking & Cont. Center Facil. Criteria, Part II, Basis for Design Bldgs & Structures, LAC Purchase Order, No 28,149, LMSD, Lockheed Sunnyvale, November 17, 1960.
Recorded – October 31, 1967.

GR25 – FAAR Forward Area Alerting Radar

Cost -- $2,983,564 for development
Discussion – The Army has ordered
To operate with the Chaparral missile/Vulcan 20 mn gun battlefield air defense system
The radar will be built by Sanders Associates, Inc. under a fixed price contract which covers design development and fabrication of initial units.
Source – Missiles & Rockets, May 23, 1966, p 13.
Recorded – June 1, 1966.

GR26 – Shipboard Tropo – Hughes Shipboard Troposcatter System
Cost -- $12 million
Discussion – for secure, long-range, over-the-horizon shipboard communications
A detail 3-ship evaluation, cost the Navy …
Source – Aviation Week, May 2, 1966, p 86
May 26, 1966.

GR27 – MSR – Missile Site Radar for Nike-X System
Cost -- $65 million total funding to …
Discussion – An additional $20.6 million to Raytheon from Bell Tel. Labs, brings total funding of the firm on MSR to more than $65 million.
Raytheon also develops the transmitter amplifier for the Multi-function Array Radar (MAR) of the anti-missile system and has received several million $ in contracts on that effort.
Source – Missiles & Rockets, April 21, 1966, p 11
Recorded – May 20, 1966.

GR28 – HAPDAR – Hard Point Demonstration Array Radar
Cost -- #3 million program
Discussion – Now undergoing Govt. acceptance tests at White Sands Missile Range, NM, where it has been in operation since October.
The radar, a 30 ft diameter planar array was developed by the Sperry Gyroscope Co, Great Neck, NY, under and ARPA contract.
Principal innovations that have led to the cost reductions have been use of a single, standard feed for the array rather than using individual transmitters for each antenna element, and development of a passive electronic phase shifting network.
Source – Missiles & Rockets, March 14, 1966, p 15
Recorded – April 8, 1966.

GR29 – Complex 4 – Modification of Space Launch Complex 4 East (SLC 4E)
Cost -- $5,222,206
Discussion – contract awarded M. M. Sundt Construction Co., Tucson, AR
To accommodate the Titan III-D/Agena E booster/satellite combination.
To be completed in mid 1969 and the first launch of the T-III D/Agena E could occur before the end of 1969.
Source – Aerospace Technology, June 17, 1968, p 10.

Recorded – July 1, 1968.

GR30 – OTH – Backscatter over the horizon radar
Cost -- $42 million
Discussion – to bounce signals off the ionosphere and the Earth and back for identification of missiles and aircraft.
$3 million in fiscal 1967
$11.3 million in fiscal 1968
$18 million in fiscal 1969
$10 to complete
Source – Aerospace Technology, June 17, 1968, p 3.
Recorded – July 1, 1968.

GR31 – AR-1 Radar
Cost – about $186,000 installed
Discussion – single radar
Normal traffic control very close range to 75 mile limit
Royal Air force – 20 units
Included pre-fabricated building to house transmitters, and optional items.
AR-1 comprises a single beam 10-cm (S-band) radar to a height in excess of 40,000 ft.
Equip. consists of an antenna, a standard tower, one or two transmitter cabinets, a log/lin receiver housed in an ancillaries rack, control unit and 2.
Source – Aviation Week, November 18, 1963, p 91.
Recorded – March 17, 1964.

GR32 – RAMPART Radar
Cost -- $4.42 equipment in 10 to the 6^{th}.
Discussion -- 0.66 – initial spares
0.88 – installation and checkout
1.11 – facilities
Source – ARPA Study No. 2, Sat. Intercep. System (Cmd), Final Report, Vol. III, P 11
Recorded – November 8, 1963.

GR33 – ZEUS MTR – Zeus Missile Tracking Radars
Cost – $0.64 times 10 to the 6^{th} equipment
Discussion-- 0.10 initial spares
0.21 installation and checkout
0.16 facilities
Source – ARPA Study No. 2, Sat. Interce. System (Cmd), Final Report, Vol. III, P 11.
Recorded – November 8, 1963.

GR34 – T.T.Radar
Cost -- $4.18 equipment times 10 to the 6^{th}.

Discussion -- 0.63 initial spares
0.84 installation and checkout
0.05 facilities
Source – ARPA Study No. 2, Sat. Interce. System (Cmd), Final Report, Vol. III, P 11.
Recorded – November 8, 1963.

GR35 – Titan M. T. R., Missile Tracking Radar
Cost – as follows
Discussion -- $2.55 equipment x 10 to the 6th.
Source – ARPA Study No 2, Satellite Intercep. System (Comd), Final Report, Vol. 111, p 11.
November 8, 1963.

GR36 – RCA FPQ-6 Target Tracking Radar
Cost – Investment $3.83 times 10 to the 6th.

Discussion – Equipment	Estimating Factors
0.57 – initial spares	15%
0.77 – installations & checkout	20%
0.96 – facilities	25%
Operations & Maint	20%

All radar costs are the average unit costs of a 3 unit order. When calculating total site costs, the radars were estimated for the actual quantity installed except the An/FPQ6, for which average costs were used for quantities up to 6.
Source – ARPA Study No. 2, Sat Intercept System (Command), Final Report, Vol III, Cost Summary, October 1963, SM-45746. p 11.
Recorded – November 8, 1963.

GR37 – Antennas
Cost – as follows
Discussion – sample of antenna costs by type of antenna (1964 prices)
Fixed Station Antennas – omnidirectional unipole antennas
