The DSN Hydromechanical Equipment Service Program

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Operational experience from the first 64-m-diam antenna (DSS 14) indicated that the increase in quantity of spares required to support the system was becoming prohibitive. With additional antennas becoming operational, it was obvious that an efficient controllable program was necessary to support the DSN. A study was conducted to determine the optimum method for providing repair, test, and calibration service in support of hydromechanical equipment. Several possible sources of service were considered; the governing factors throughout the comparison phase of the study were cost and reliability. Major consideration was given to conservation of skilled personnel, control of service environment, turnaround time, and the adoption of an oil sampling and contamination control program. This article summarizes the results of the study and the present and future status of the program.

I. Introduction

In 1970 a detailed study was performed by I. D. Wells (DSN Antenna Servo-Mechanical Cognizant Operations Engineer) to determine the optimum method for providing repair, test, and calibration services in support of hydromechanical equipment. The study was performed because the advent of the first 64-m-diam antenna (DSS 14) had indicated that the quantity of spares required to support the system would soon become prohibitive (one 64-m antenna contains more hydromechanical subassemblies than the entire net of 26-m antennas). With two more 64-m antennas planned and a possible total of six, it was obvious that an efficient controllable program was necessary to support the DSN.

II. Study Summary

The study considered several possible sources of service: Manufacturers and vendors, a single DSN service facility, and a service facility at each major DSN geographic location. The governing factors throughout the comparison phase of the study were cost and reliability. Major consideration, in support of these two factors, was given to: (1) conservation of skilled personnel, (2) control of service environment, (3) turnaround time, and (4) the adoption of an oil sampling and contamination control program.

Figure 1 portrays the past, present (1971), and projected replacement costs of all items comprising the equipment population. Pumps, motors, and servo-valves are considered as major items because they (1) constitute 87% of the replacement costs, (2) require more servicing actions, (3) are the most expensive to repair, and (4) have the longest turnaround time under present servicing methods. The remaining items (gauges, accumulators, pressure valves, and miscellaneous items) are defined as minor items. If the present method of "servicing on demand" is continued, the useful life of these items will be shortened due to the extended service without periodic overhaul. This will be particularly true of the major items. Even a conservative attrition rate of 2% per annum would mean a replacement cost of approximately $5500 yearly on major items placed in service prior to 1971.

The least biased approach to equipment failure prevention is scheduled servicing using experienced mean time between failures (MTBF) data. Research in this area revealed that data available at the present time would not support such a program with the accuracy that is required. The next most logical approach appeared to be equipment servicing on a periodic recall basis. The expected equipment failure rates were established by (1) using manufacturer's recommended overhaul times (expressed in thousands of hours), (2) assuming the adoption of an oil sampling/contamination control program, and (3) a careful examination of failures noted on various DSN records over 4 years prior to 1971. These rates were then equated into the yearly recycle rates shown on Fig. 2. These rates may be adjusted based on wear rates derived from oil analysis and measured in recalled equipment.

Figure 3 compares the cost differential between servicing by the DSN Maintenance Center (DMC) on a periodic basis and the equivalent service performed by a vendor. The DMC costs, shown in the foreground of the figure, detail the breakdown of costs on an annual basis. The annual manhour requirements to repair the various items of equipment are shown on Fig. 2. The cost of establishing the facility is written off in the first year instead of the usual amortization practice. This accounts for the disparate cost of the first year as contrasted to the succeeding years.

To lend credence to the cost of "servicing on demand" shown prorated to 1971 and also projected through 1972, the records for the period January 1, 1966 through November 15, 1969 were analyzed. The prorated annual cost for the period was $37,000. Assuming that this cost would remain fairly constant through 1972, plus the previously assumed 2% replacement attrition, a conservative annual cost of approximately $45,000 was given to continue the "on demand" type of vendor servicing.

Oil sampling by the DMC would result in a saving of over $17,000 during the 6-year period covered by this study (1970–1976).

The probability of equipment servicing on the complex level was evaluated and deemed as being too costly ($60,000 annually) and would result in inefficient utilization of personnel.

Figure 4 recapitulates the annual savings that can be expected by graphically comparing the costs between periodic servicing performed by a vendor and a hydromechanical facility in the DMC. The light dash line represents the facility costs and the heavy dash line represents the vendor costs, projected through 1976.

III. Results of the Study and Present Status

The study revealed that a central DSN Hydromechanical Service Facility would be the most effective method of rendering support. The recommendations to DSN management were:

(1) Establish periodic recall and service of all hydromechanical equipment, except servo-valves, at a central facility by July 1, 1971.

(2) Establish periodic service of servo-valves by July 1, 1975.

(3) Perform oil sampling and analysis as soon as possible after September 1, 1970 (the date the report was submitted).

The first services of hydromechanical equipment were performed during mid-1972. There was no recall established at this time because budget constraints had limited the growth rate of the facility. By January 1973 enough of the facility had been installed to begin recalling hydromechanical equipment. DSS 12 was the first station to be serviced and during 1973 the remainder of the Deep Space Stations will be included.

The first oil samples were taken at DSS 61 during February 1972. Since then samples have been taken at other stations and subsequently analyzed and reported. This effort has already proven effective by disclosing, in several instances, a buildup of contaminants and in one instance a breakdown of hydraulic oil, in another a failing bearing in a main pump. As a result the stations were given specific instructions to correct the situations.

The fluid analysis capability provides the DSN with a direct method of monitoring the online status of fluid systems, whether they are antenna servo hydraulics, power generator diesel engines or water coolant systems.

The initial efforts at recalling and overhauling hydromechanical subassemblies has revived interest in a phenomenon called "hitching." This is an effect where two apparently identical hydraulic motors in the antenna drive, supposedly working in concert, tend to bind or impede each other because of difference in their respective flow rates. The normal tolerances in the flow rate specifications of new motors apparently allows enough of a difference between two motors to allow "hitching" to occur. All motors that work in pairs in the system will be provided in matched sets to improve the "hitching" problem.

IV. The Future

During the next one to two years, the hydromechanical service facility is to be developed for full coverage of both the 26-m and 64-m antenna hydromechanical service. Because of the similarity of support requirements, the analysis of power generator lubricating oil has been considered as a possible task.

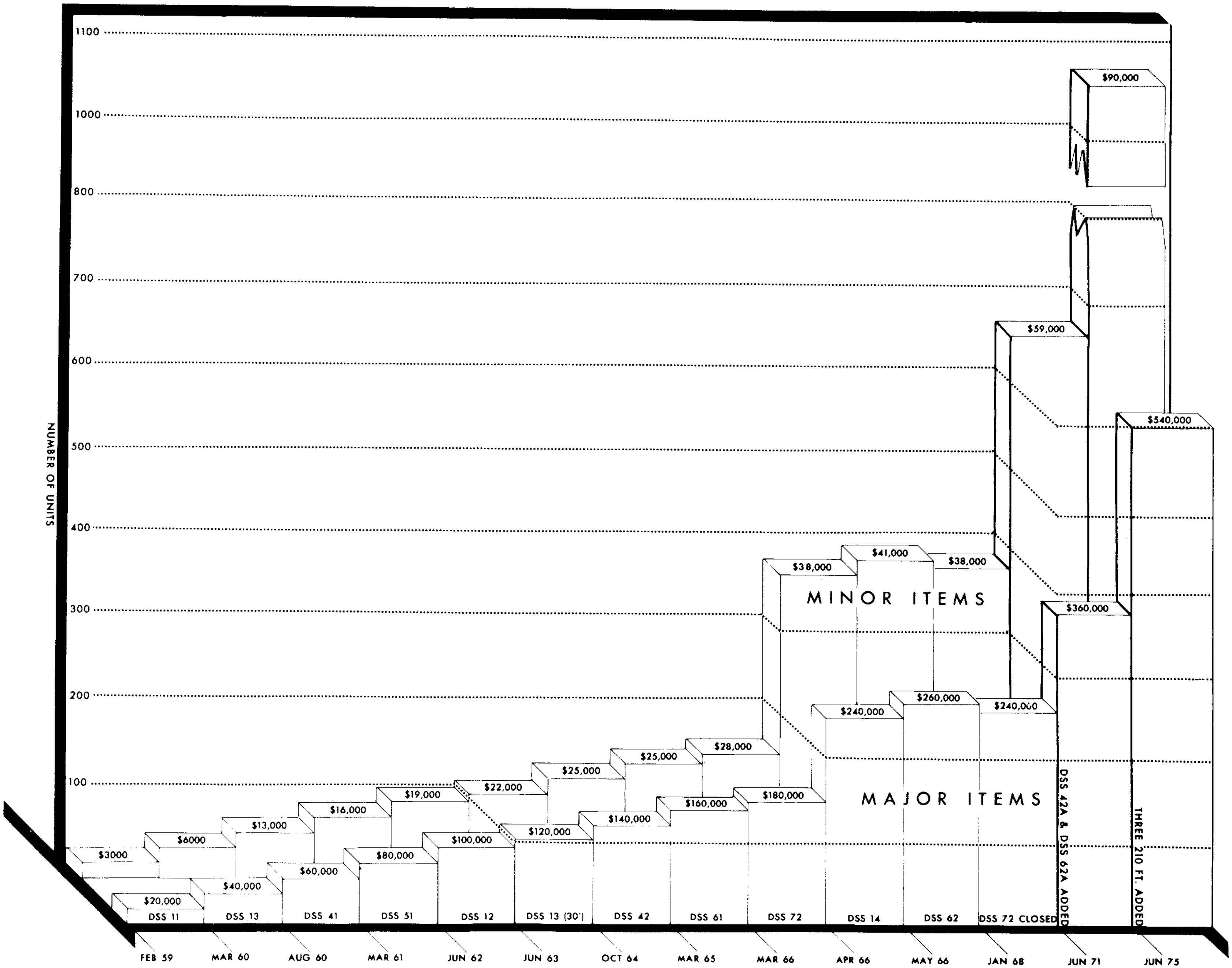

Fig. 1. Equipment population and replacement cost

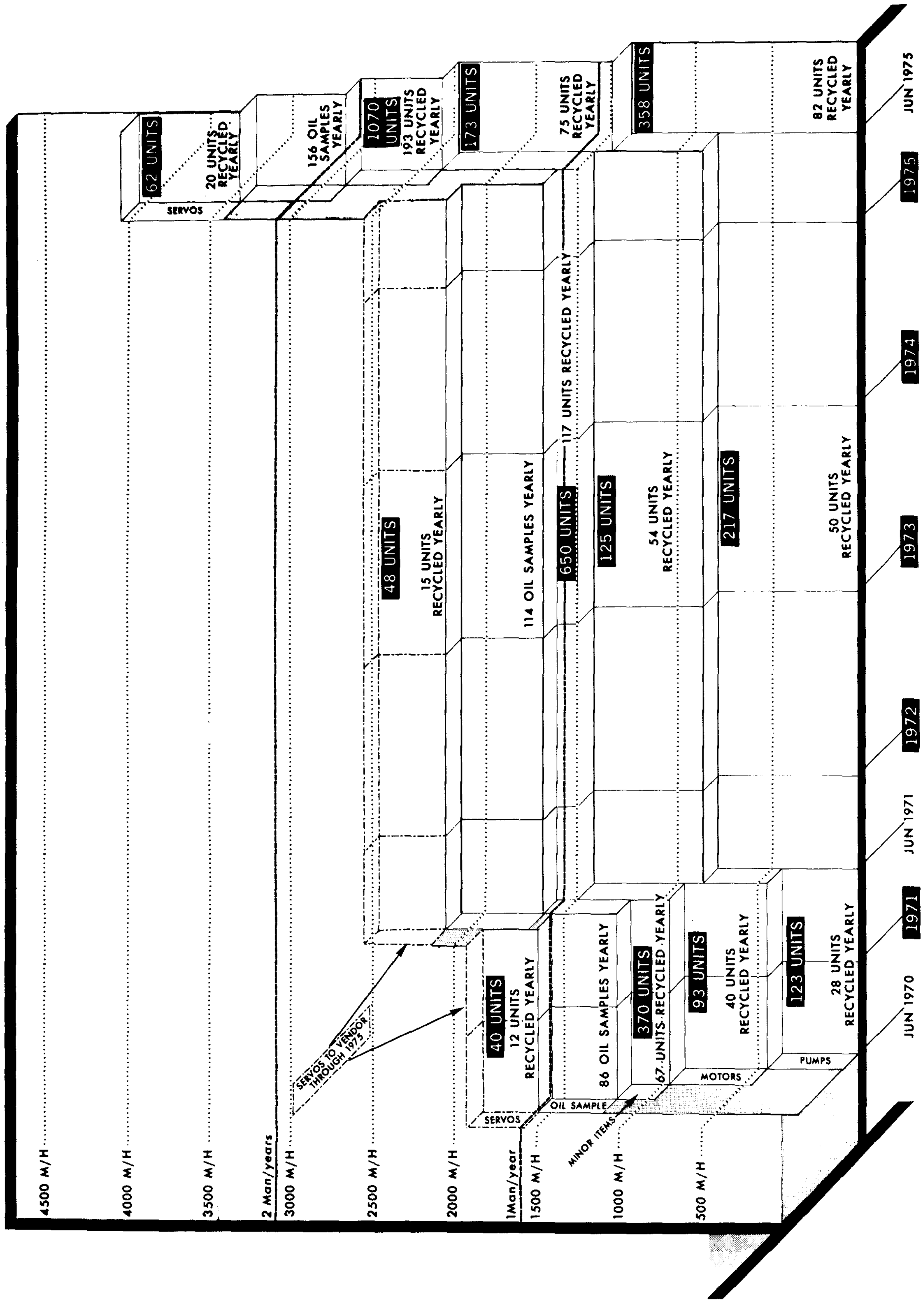

Fig. 2. Equipment recycle rate (yearly) and manhours to repair, including oil sampling

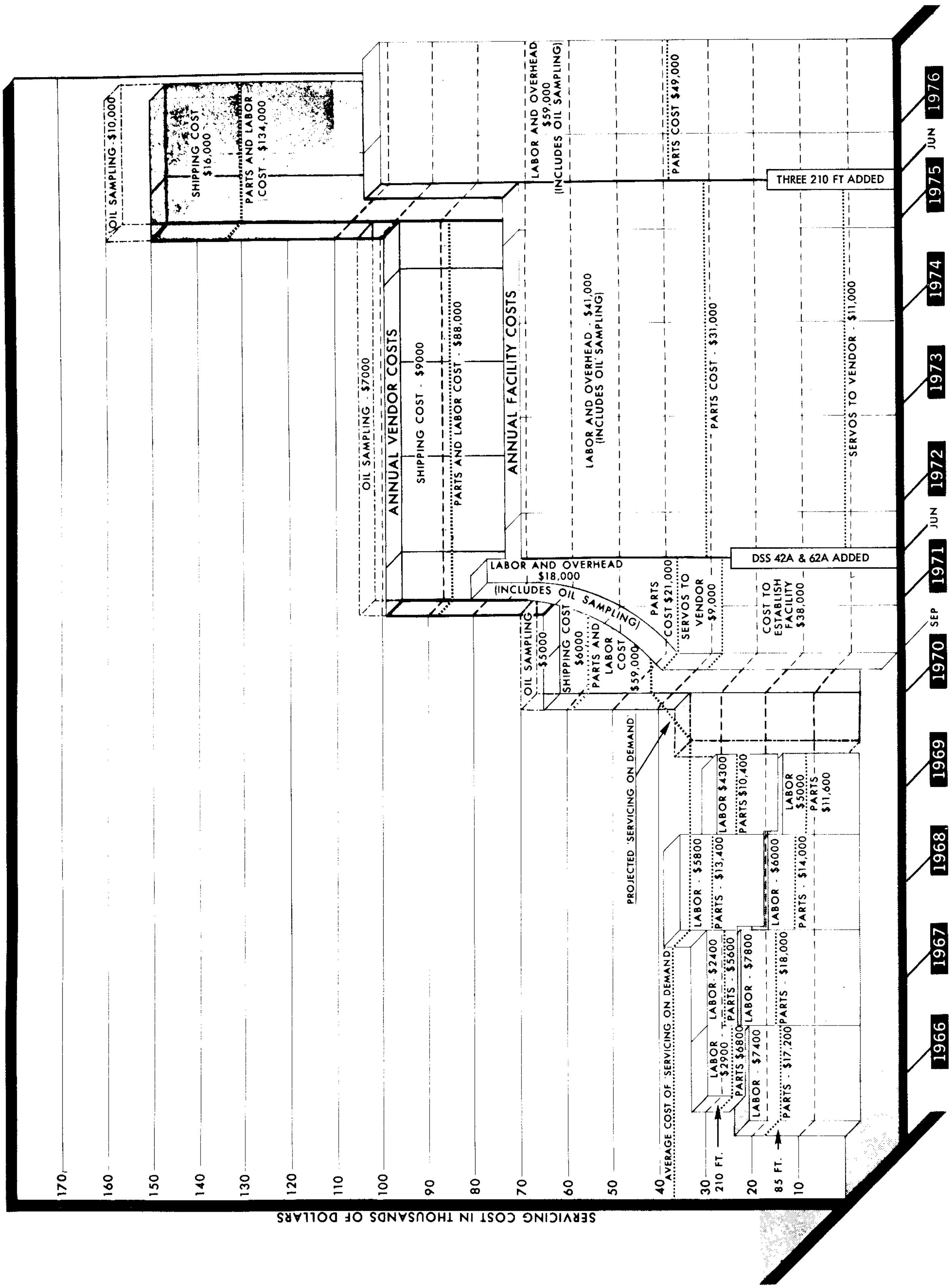

Fig. 3. Comparison of vendor and DMC facility servicing costs

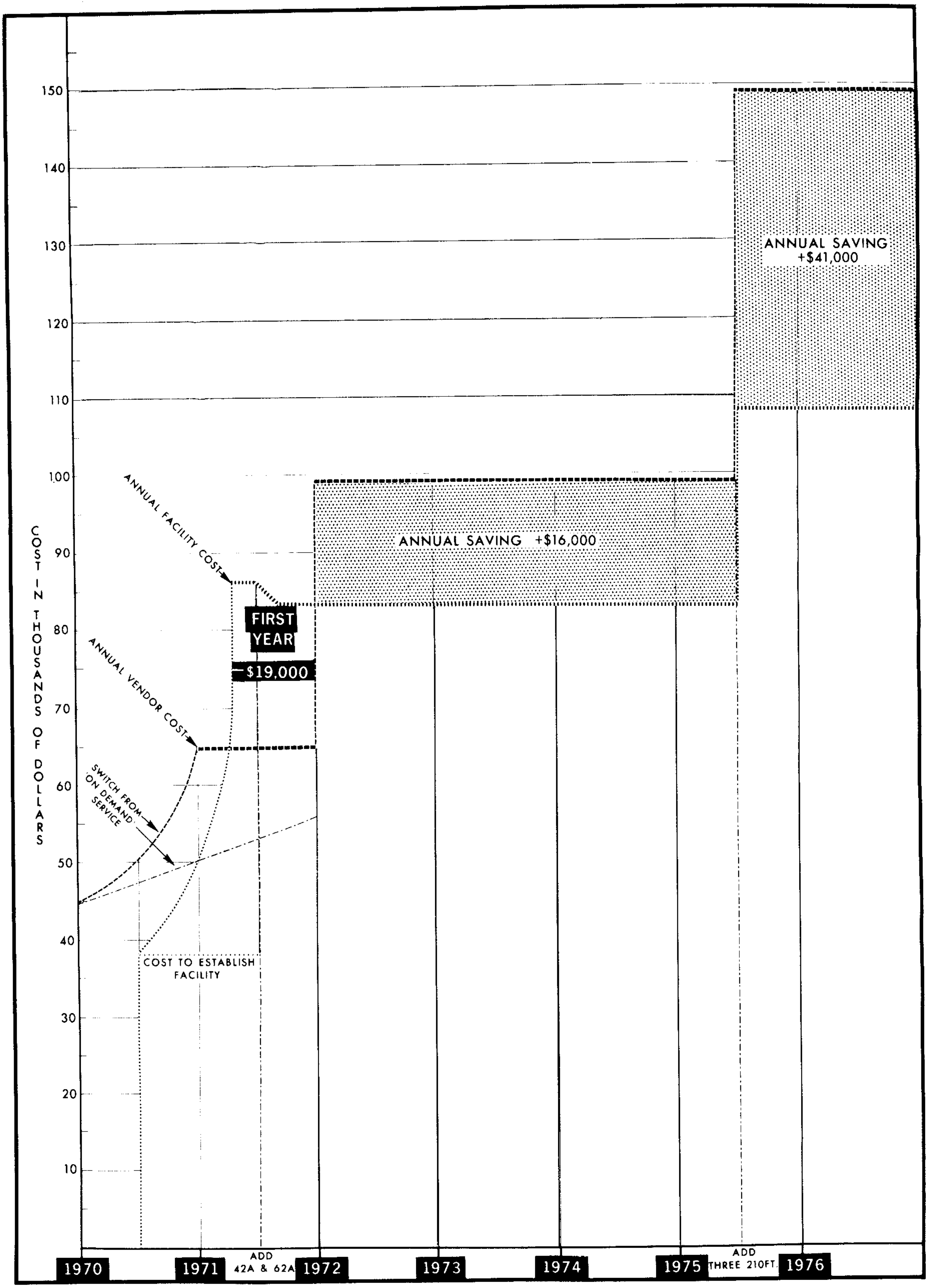

Fig. 4. Recapitulation of annual savings