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DMPA INJECTABLE USE: FINDINGS FROM THE 21-MONTH DMPA MONITORING STUDY

Final Report B

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The Population Council, Manila
in collaboration with
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DMPA INJECTABLE USE:
Findings from the 21-Month DMPA Monitoring Study

INTRODUCTION

This report presents the results of the DMPA Monitoring Study undertaken by the Population Council, Manila as a technical assistance project for the DMPA Reintroduction Program of the Department of Health (DOH). The primary objective of the study is to provide data on DMPA utilization and continuation rates, as may be used to project the logistical needs of the program during the next three years. Data on the availability of DMPA supplies and on IEC (information, education and communication) materials relating to DMPA were also monitored to provide some measure of the effectiveness of the program's distribution system.

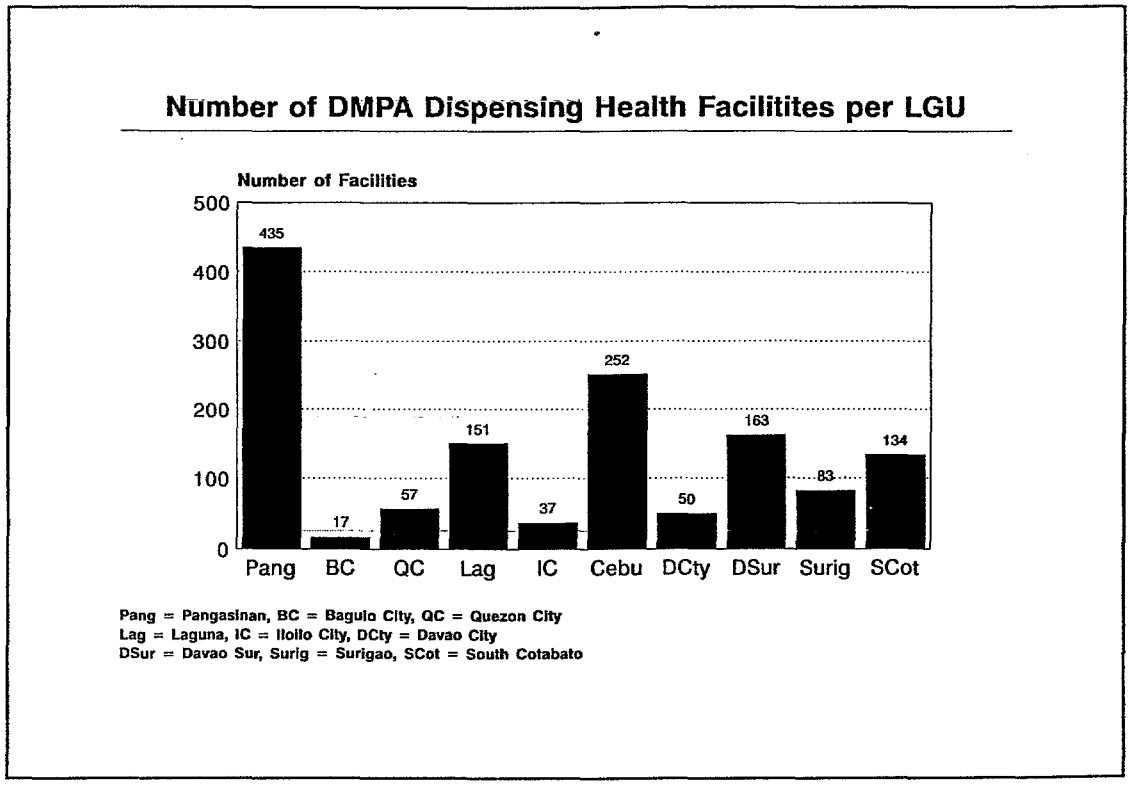
The study covers a 21-month observation period from April 1994 to December 1995 and concentrates on 1,379 DMPA-dispensing health facilities in the ten local government units (LGUs) covered by Phase I of the DMPA Reintroduction Program. These LGUs are Baguio City, Quezon City, Laguna, Pangasinan, Iloilo City, Cebu, Davao City, Davao del Sur, South Cotobato and Surigao del Sur. Pangasinan and Cebu were by far the largest of these, being able to account for nearly half of all the facilities covered by this report (see Figure 1). Data are based upon reports received as of February 29, 1996 from at least 80% of the total DMPA-dispensing facilities in these pilot LGUs.

An earlier report (Final Report A) was prepared in August 1995 covering the months from April 1994 to June 1995.[1] This report (Final Report B) will also integrate

[1]This report (Population Council, Manila, 1995) was termed as "final" because the study was originally conceptualized as incorporating a fifteen-month data collection component. A request was subsequently made by the DMPA Task Force, however, to extend the study by another six months in order to provide a stronger empirical basis for projecting future trends.

information generated from monitoring reports for the period July to December 1995. The same 1,379 DMPA-dispensing facilities were asked to submit reports to the Population Council during this six-month period.

Figure 1



OBJECTIVES OF THE MONITORING STUDY

The primary objective of the monitoring study has been to obtain information on the level and patterns of DMPA use in the ten pilot LGUs to serve as a basis for determining logistical needs up to 1998. Other goals of the study focussed on the aim of collecting information on the DMPA drop-out problem, on the effectiveness of the program's system for distributing DMPA-related supplies, and on inter-LGU differentials in program performance.

METHODOLOGY

The methodology adopted for the additional 6-month observation period (July to December 1995) was similar to the procedure utilized during the first part of the study. For example, a "reporting officer" was again designated for each of the 1,379 dispensing facilities. A distinction can be made, however, with regard to the frequency with which reports were to be submitted. During the first fifteen months of the project, these were to be sent to the Population Council office on a monthly basis. In comparison, reports were to be prepared and submitted every three months during the final six-month period. A revised monitoring form was designed for this purpose (see Figure 2).[2]

Data from the monitoring forms were encoded and data processed at the Population Council office. Two quarterly reports (Fifth and Sixth Progress reports respectively) were prepared covering the months July-September and October-December, 1995.

[2]Worth noting, though, is the fact that many of the reporting officers continued to use the original version of the reporting form, i.e. to submit their reports on a monthly basis. As a result, it was still possible to compute monthly reporting rates for the participating facilities (see below, Figures 3 and 4).

Figure 2. DMPA Monitoring Form

Report Number: 1
ORIGINAL: To be submitted

DMPA PROJECT MONITORING FORM

(To be filled out in pencil or black pen by the designated DMPA provider in the Health Facility)

1. FHSIS/CDLMIS FACILITY ID#: /_/_/-/_/_/-/_/_/-_/_/_/-/_/_/_/-/_/_/

2. BARANGAY: /_/

3. MUNICIPALITY: /_/

4. CITY/PROVINCE: /_/

5. TYPE OF FACILITY:
   - ☐ RHU ☐ PUBLIC HOSPITAL ☐ OTHER GO CLINIC
   - ☐ BHS ☐ NGO CLINIC ☐ OTHERS
   - ☐ MAIN HEALTH CENTER Specify:_____

6. MONTHS COVERED BY THIS REPORT: July-September 1995

7. NO. OF DMPA INJECTIONS ADMINISTERED DURING REPORTING MONTH:

   HOW MANY ARE:

	JUL	AUG	SEP
a) First Injections	:/_/_/_/	/_/_/_/	/_/_/_/
b) Reinjections	:/_/_/_/	/_/_/_/	/_/_/_/
TOTAL	:/_/_/_/	/_/_/_/	/_/_/_/

8. AVAILABLE DMPA STOCK AT THIS FACILITY AT THE END OF THE FOLLOWING MONTHS:

	JUL	AUG	SEP
a) No. of DMPA Vials	: /_/_/_/	/_/_/_/	/_/_/_/
b) No. of DMPA Syringes	: /_/_/_/	/_/_/_/	/_/_/_/

9. NUMBER OF TRAINED PROVIDERS ADMINISTERING DMPA AT THIS SERVICE FACILITY :

JUL	AUG	SEP
/_/_/	/_/_/	/_/_/

10. DO YOU HAVE DMPA LEAFLETS FOR CLIENTS AT THIS FACILITY?

JUL	AUG	SEP
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

11. DO YOU HAVE DMPA REMINDER CARDS FOR CLIENTS AT THIS FACILITY?

JUL	AUG	SEP
☐ Yes ☐ No	☐ Yes ☐ No	☐ Yes ☐ No

12. NAME OF REPORTING OFFICER:_____

13. TITLE OR POSITION:_____

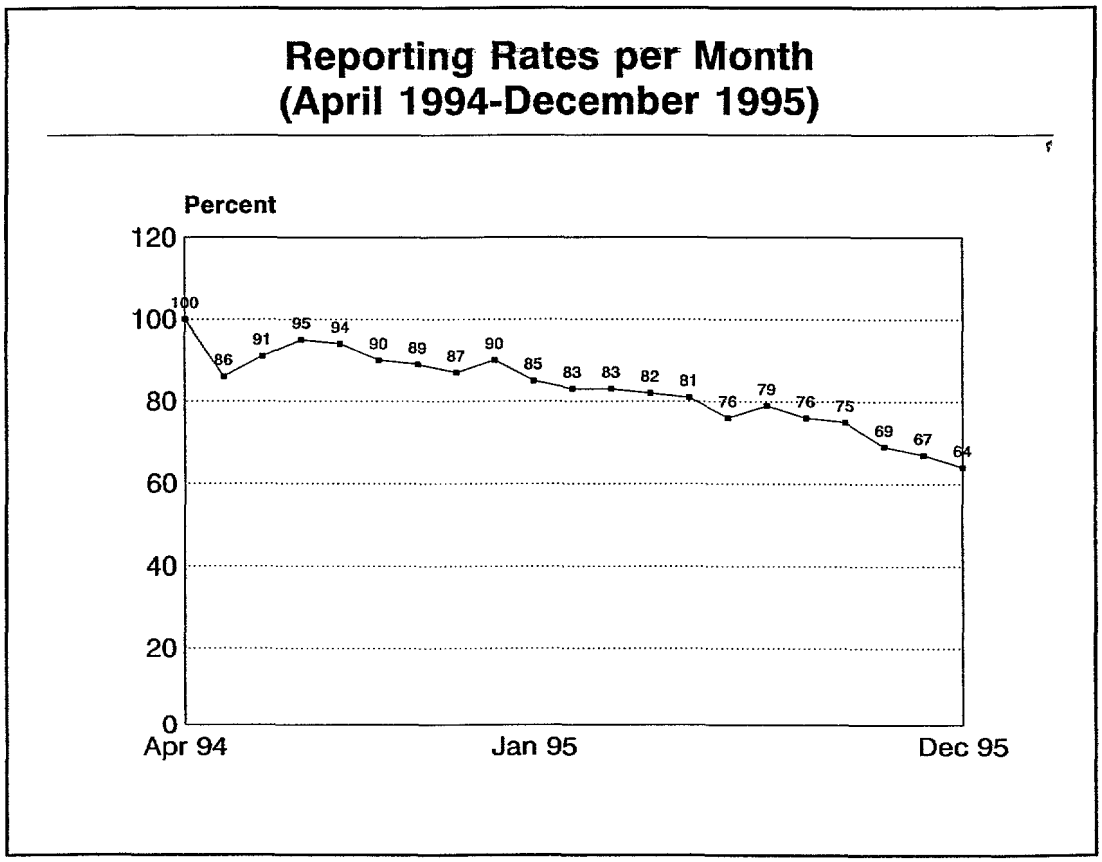
14. DATE THIS FORM WAS FILLED OUT: /_/_/_/-/_/_/19_/
    month day year

IMPORTANT: Retain the duplicate (blue) copy in your Health Facility. See "Instructions for Filling out the DMPA Project Monitoring Form".

Source of Data

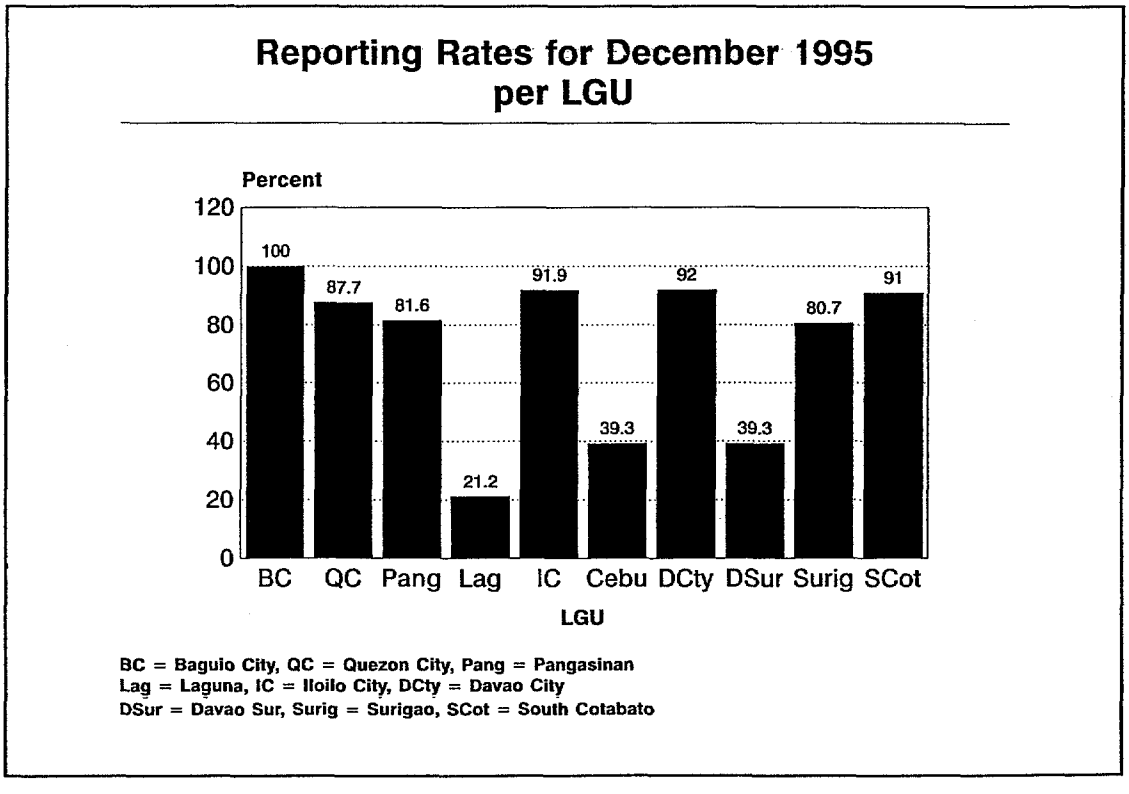
Data for this report are based on monitoring forms for April 1994 to December 1995, which had been received at the Population Council office as of February 29, 1996. During the twenty-one month observation period, all except thirty-nine of the 1,379 DMPA service delivery outlets submitted at least one monthly report. Submission rates were highest during the first nine months of the study, with an average reporting rate of 91 percent. This fell to 82 percent during the next six months and then again to 72 percent for the period July-December 1995. Figure 3 shows trends over time in this regard.

Figure 3



The lowest reporting rate occurred for December 1995, the last observation month, when only 64 percent of the facilities submitted their report. This was due largely to the very low reporting rates turned in at this time by such big provinces as Laguna, Davao Sur and Cebu (see Figure 4). Submission rates for all other LGUs were higher than 80 percent at this time.

Figure 4



RESULTS OF THE MONITORING STUDY

A. DMPA Utilization

A total of 157,662 DMPA injections were reported to have been dispensed in the ten pilot LGUs within the 21-month observation period between April 1994 and December 1995. As shown in Figure 5, a total of 62,736 (or 39.8 percent) of these were given as first injections to new DMPA acceptors, while 94,926 (or 61.2 percent) were given as reinjections. Reinjections include second, third, fourth, fifth, and sixth injections.

Figure 5

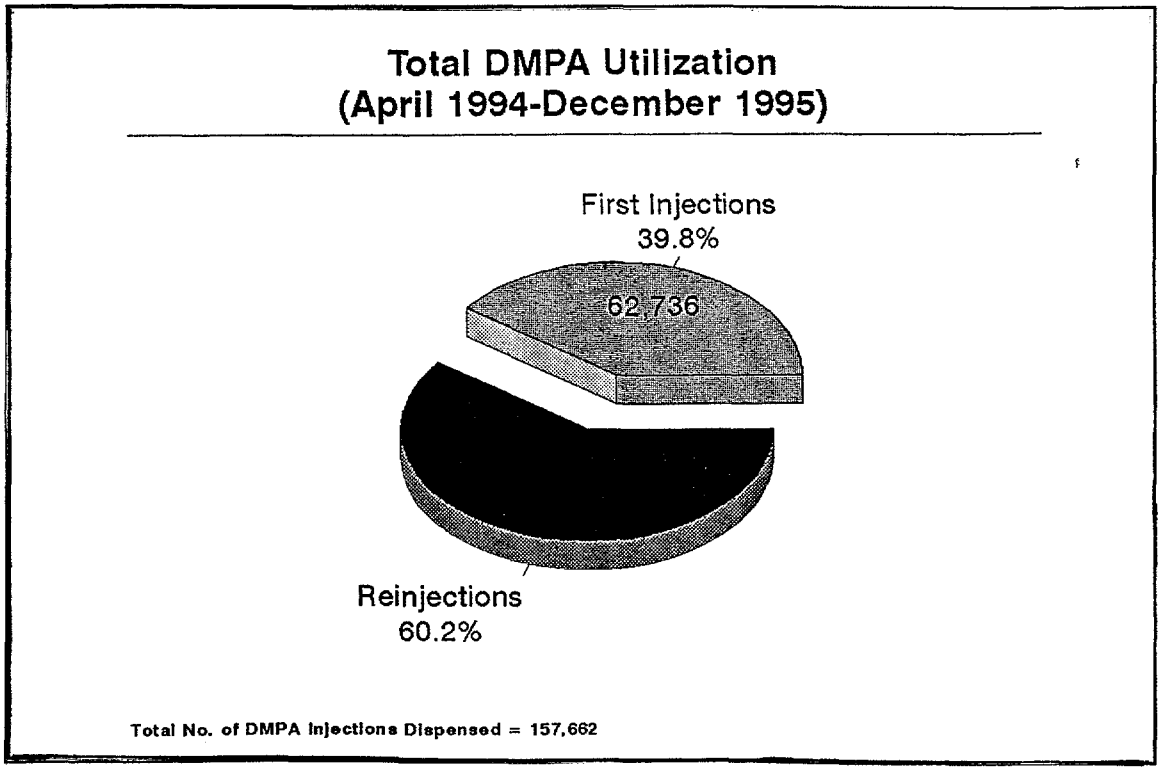


Figure 6

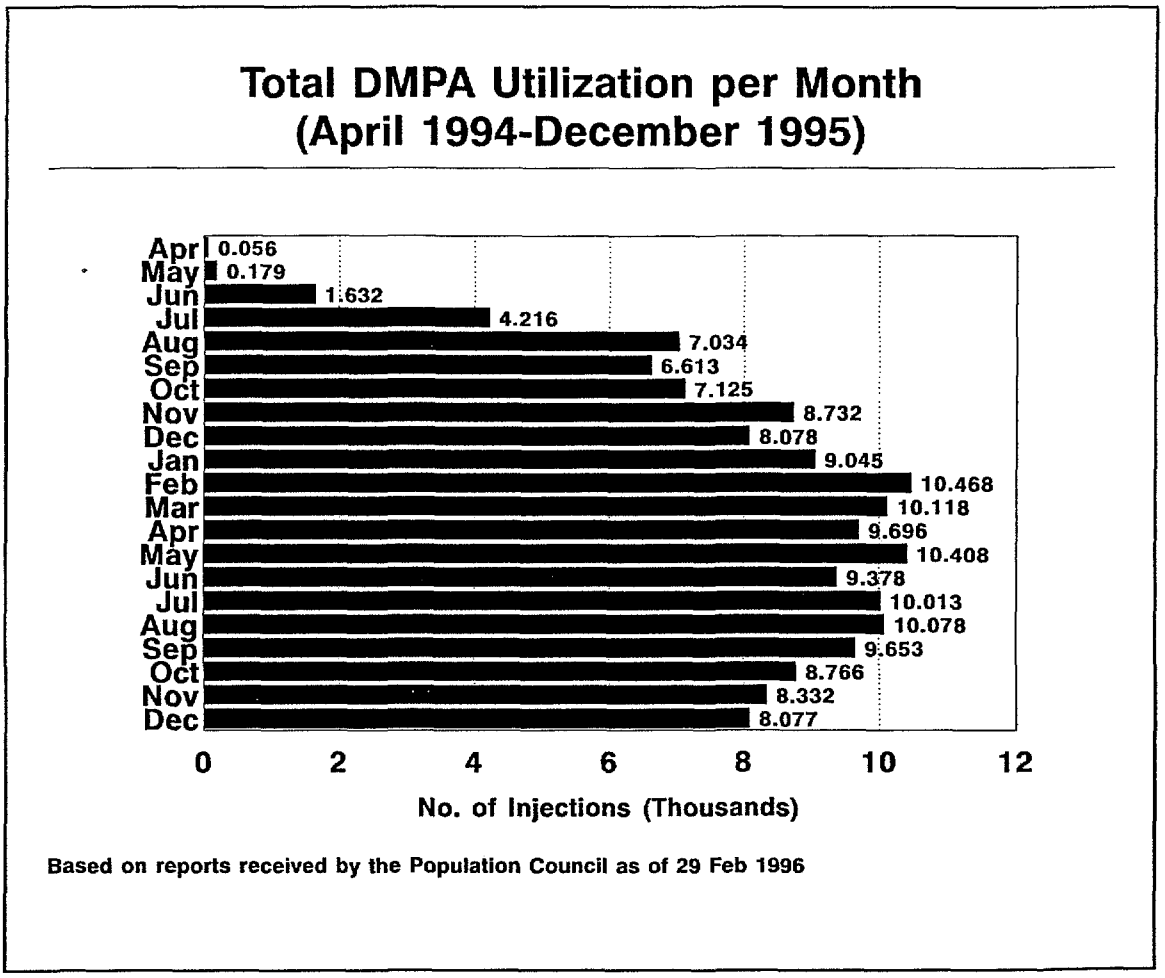


Figure 6 shows that levels of DMPA utilization were low during the first quarter (April-June 1994). Training sessions for service providers were still ongoing at this time. A total of only 1,867 injections were dispensed during this period.

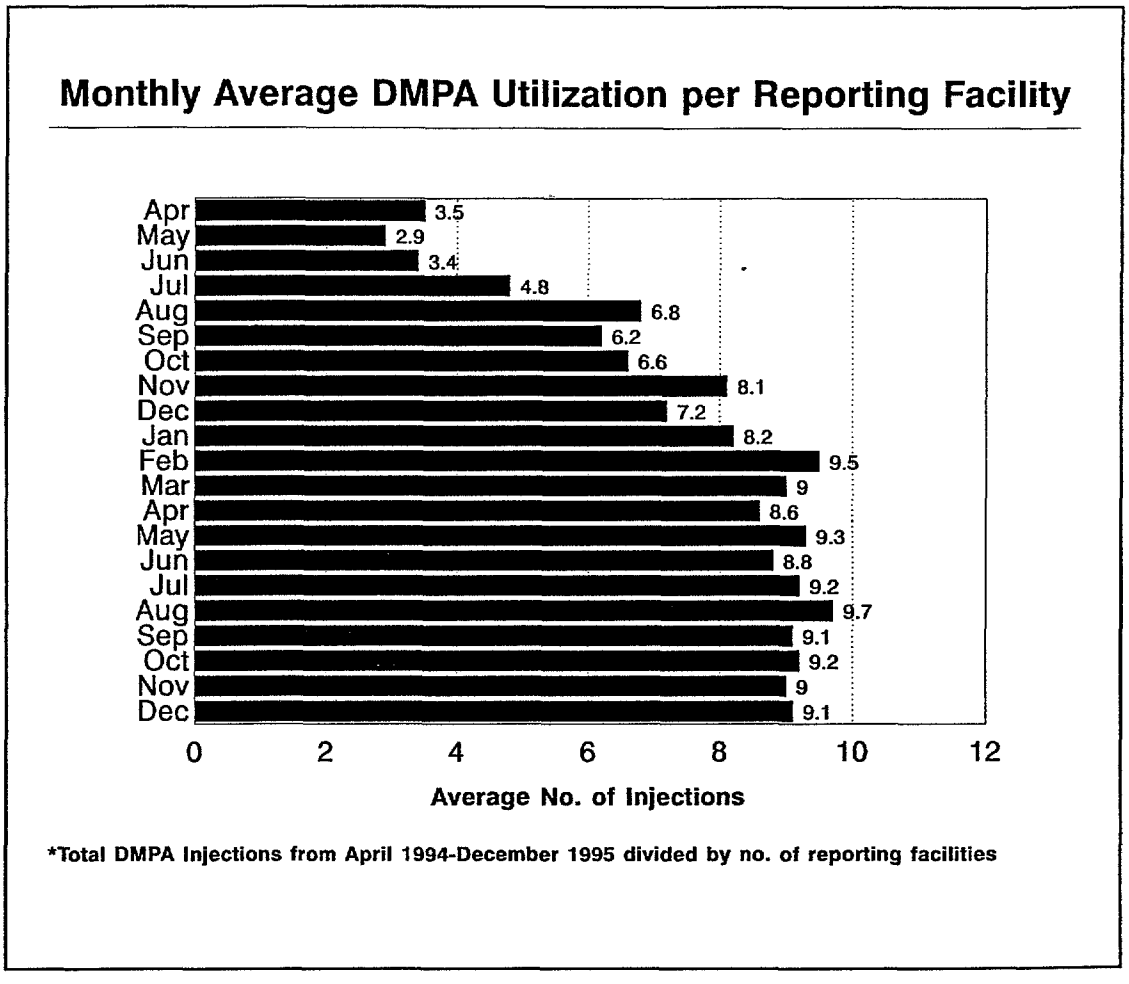
A significant increase can be noted during the second quarter of the study, particularly during the month of August when a total of 7,034 injections were reported to have been dispensed. Utilization levels continued to increase to 8,732 during the month of November and then to 10,468 injections by February 1995. The number of injections then declined slightly during March and April although a small increase was registered by May when the

total number of injections again exceeded 10,400. A gradual decline then set in during the remaining seven months, so that they reached a low point of 8,077 injections as of December, the last month included in the observation period.

These data raise an important question. Should the eventual decline in DMPA use be attributed to the fact that a decreasing number of facilities were submitting their monitoring forms during the latter half of this study or has there been an actual falling off in the popularity of this family planning method? One way to answer this question is to look at trends over time in the number of DMPA injections given out per reporting facility. Should it prove true that this statistic has been increasing or at least remaining steady during this period, the most likely explanation for the above findings would probably be that they are largely an artifact of the reduced submission rates experienced during the course of the study.

Figure 7 allows us to examine this issue. It shows that the highest monthly average injections per facility was 9.7 during the month of August 1995. Per facility injection levels during the next four months hovered around 9.1, a level which was still somewhat higher than those which were generally reached during 1994 and the first half of 1995. The major reason for the apparent decline in DMPA use must therefore be attributed to the reporting factor, i.e., the decline over time in the number of facilities willing to submit their monitoring forms.

Figure 7



Altogether, facilities in the pilot LGUs averaged about 3 or 4 injections per month during the first quarter (i.e., the training period). This increased to about 6 or 7 injections per facility during the second quarter, 7 or 8 injections during the third quarter, and 9 injections after that. For the whole 21-month observation period, the program dispensed an average of 7.5 injections per facility per month.

Figure 8

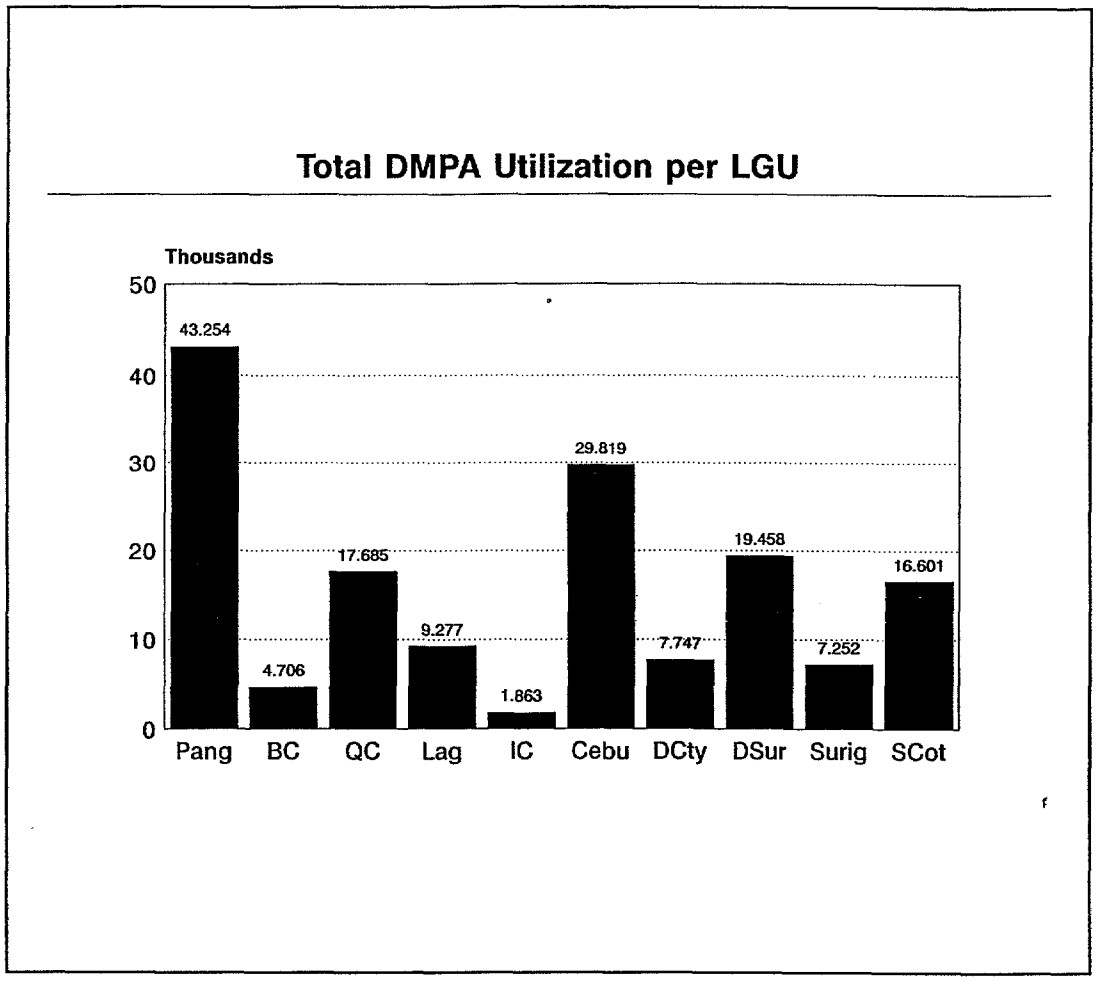
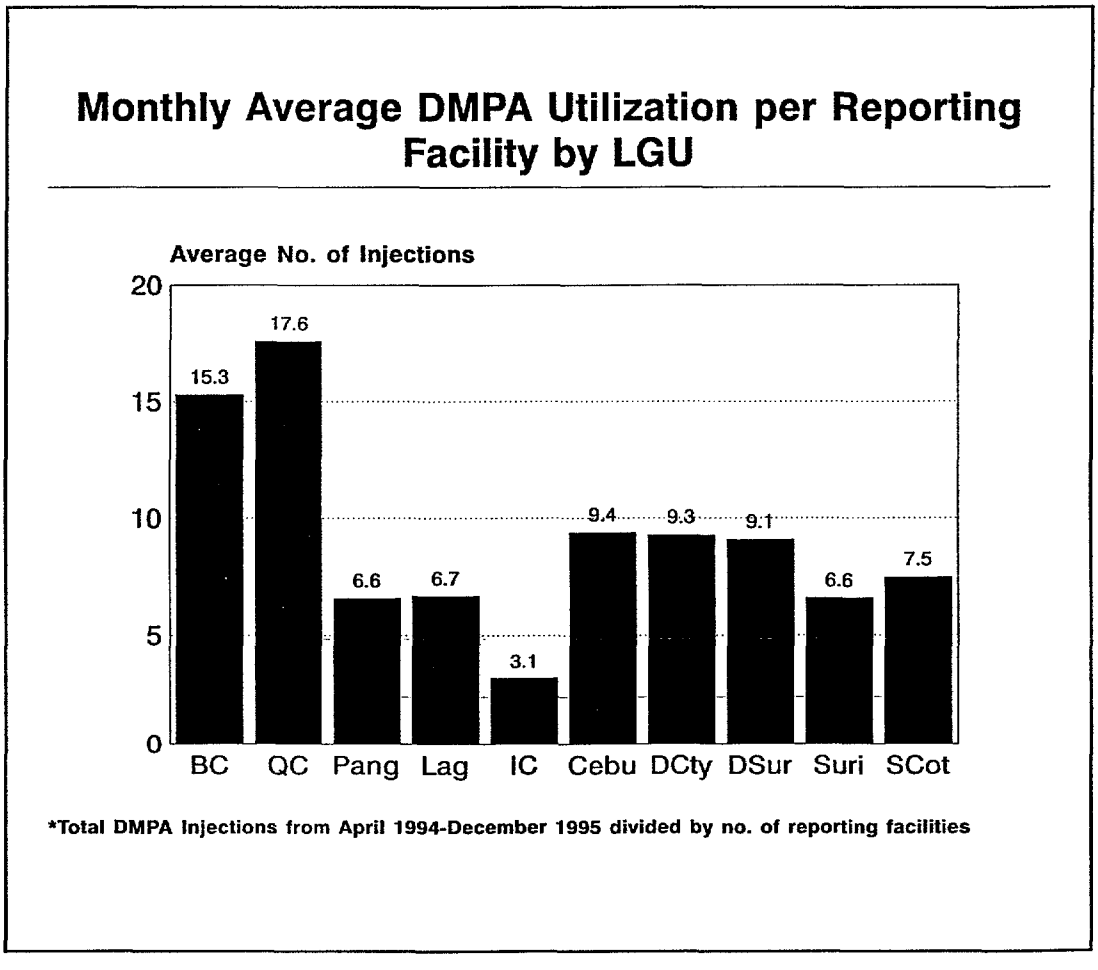


Figure 8 reveals that overall levels of DMPA utilization were reported to be highest in Pangasinan and lowest in Iloilo City. Health facilities in Pangasinan recorded a total of 43,254 injections within the 21-month period as compared to only 1,863 injections in Iloilo City. Cebu province ranked second with a total of 29,819 injections while Davao Sur recorded 19,458.

The above figures are affected, to some extent, by the larger base populations and number of facilities found in such provinces as Pangasinan and Cebu. We have therefore again used per facility statistics to control for this factor. The resulting data (shown in Figure 9) reveal that, in terms of the average number of monthly acceptors per facility, it is Quezon City that showed the highest output, with a mean level of 17.6 monthly injections over the 21-month observation period. Baguio City ranked second with an average of 15.3 injections dispensed per facility per month. While these figures might at first be taken to indicate that urban-based facilities are the best able to attract large numbers of DMPA users, it is interesting to note that one of the two other chartered cities in our sample of LGUs (i.e., Iloilo City) ranked lowest in this regard, with a monthly average of only 3.1 injections.

Figure 9



Among the remaining LGUs, the provinces of Cebu and Davao Sur along with Davao City had an average of 9 or more injections per month. South Cotabato was lower still at 7.5 while Pangasinan, which had recorded the highest cumulative total injections among the LGUs, and Surigao del Sur both averaged only 6.6 injections per facility per month.

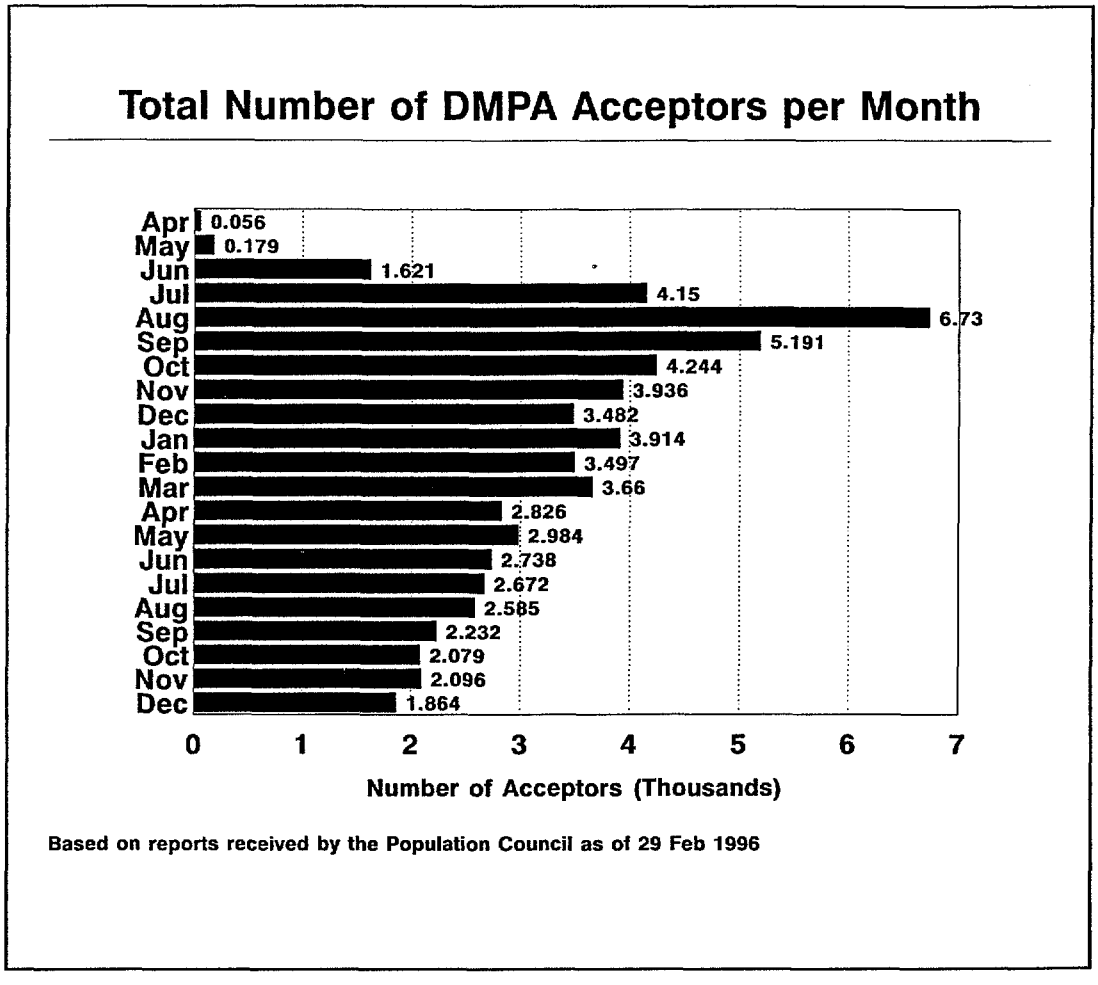
As a whole, the sample cities averaged 11.6 injections per facility per month while the provinces averaged 7.6 injections per facility per month.

B. DMPA Acceptance

Findings discussed above refer to the total number of DMPA injections. Let us now disaggregate these figures into their two major components; i.e., DMPA acceptors (first injections) and DMPA reinjections. Figure 10 initiates this portion of the analysis by providing data on the number of first injections.

In general, the total number of DMPA acceptors (or first injections) in the pilot LGUs was low during the first quarter but increased significantly in August 1994, after the completion of the training sessions for service providers. This month recorded the highest number of acceptors within the 21-month period (6,730). This figure thereafter declined noticeably to a level less than one third as large (1,864) as of December 1995. Overall trends in this regard are shown in Figure 10.

Figure 10



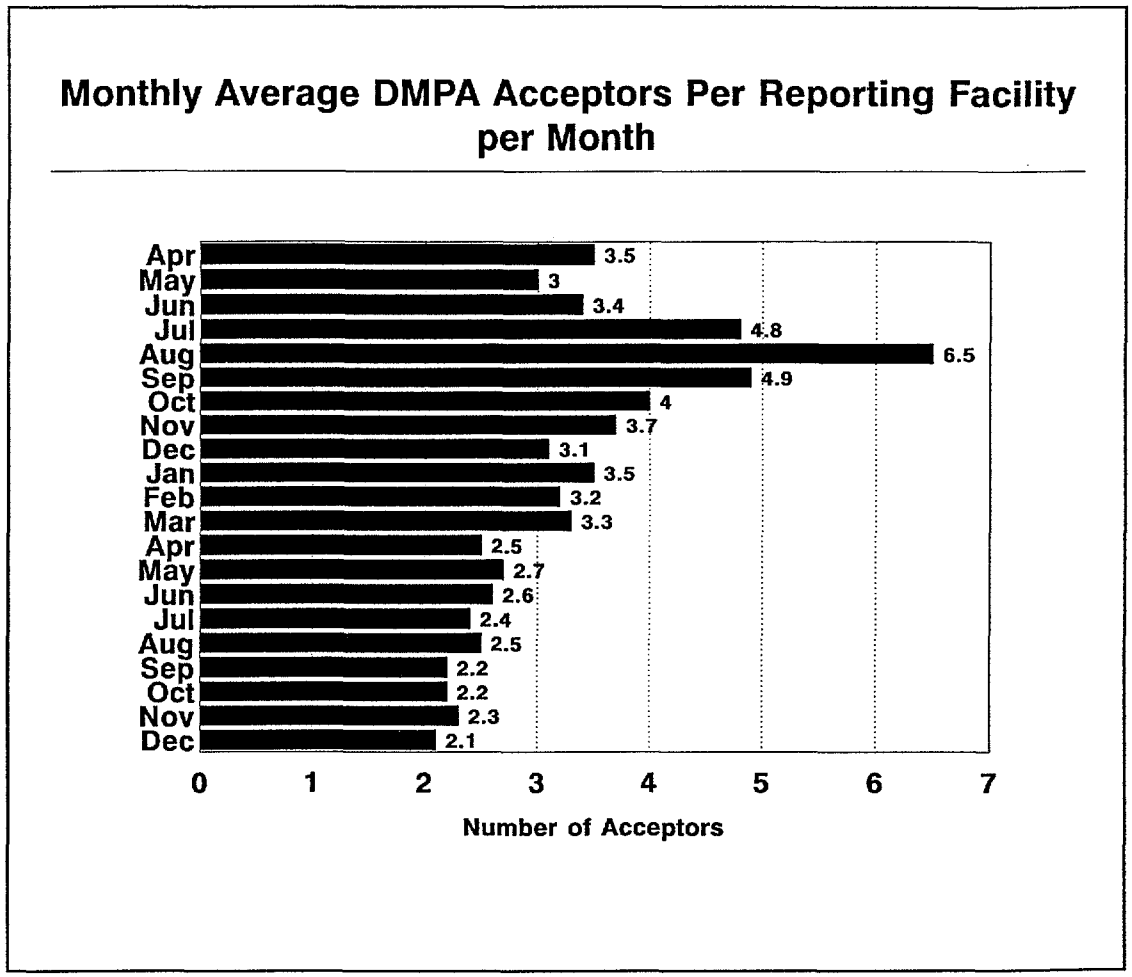
From the August 1994 high of 6,730 first injections, the total number of acceptors dropped to an average of about 4,000 per month during the third quarter. This later declined further to roughly 3,700 and 2,800 acceptors each month as of the fourth and fifth quarters, respectively. During the six-month extension period of the study additional declines were noted with the monthly averages at this time being about 2,500 first injections for July-September 1995 and 2,000 acceptors during October, November and December of that same year.

The magnitude of this decline indicates that it may well be due to more than just a matter of reduced submission rates. One way of checking this supposition is to examine the average number of first injections per facility. As shown in Figure 11, these figures indicate that there has indeed been a secular decline in the number of women accepting DMPA. For example, an average of about 5 acceptors were being noted each month by the reporting facilities during the period July to October 1994. During the next five months this figure fell to about 3.5 DMPA acceptors per month followed by nine straight months with averages below 3.0 acceptors. The average for December 1995 (the last month of the study) was only 2.1, the lowest figure recorded during the 21-month period covered by the study.

These findings do not speak well for the prospects that DMPA will capture a large segment of Philippine family planning market. It seems that the demand for new injections was already going into a major decline before the reintroduction program had completed a year of operation. In attempting to explain this pattern, we may point to the hypothetical importance of two different factors. One possibility is that there is a sort of "ceiling effect" operating here; i.e., that only a maximum of 5 to 10 percent of all married women of reproductive age in the Philippines would ever be likely or interested to accept DMPA.[3] A second hypothesis worth considering, though, is that the reintroduction program itself began to "lose steam" after the first few months, with the result that fewer and fewer women were ever being informed about their option to use this FP method. Further research will be needed to determine the comparative validity of these two explanations.

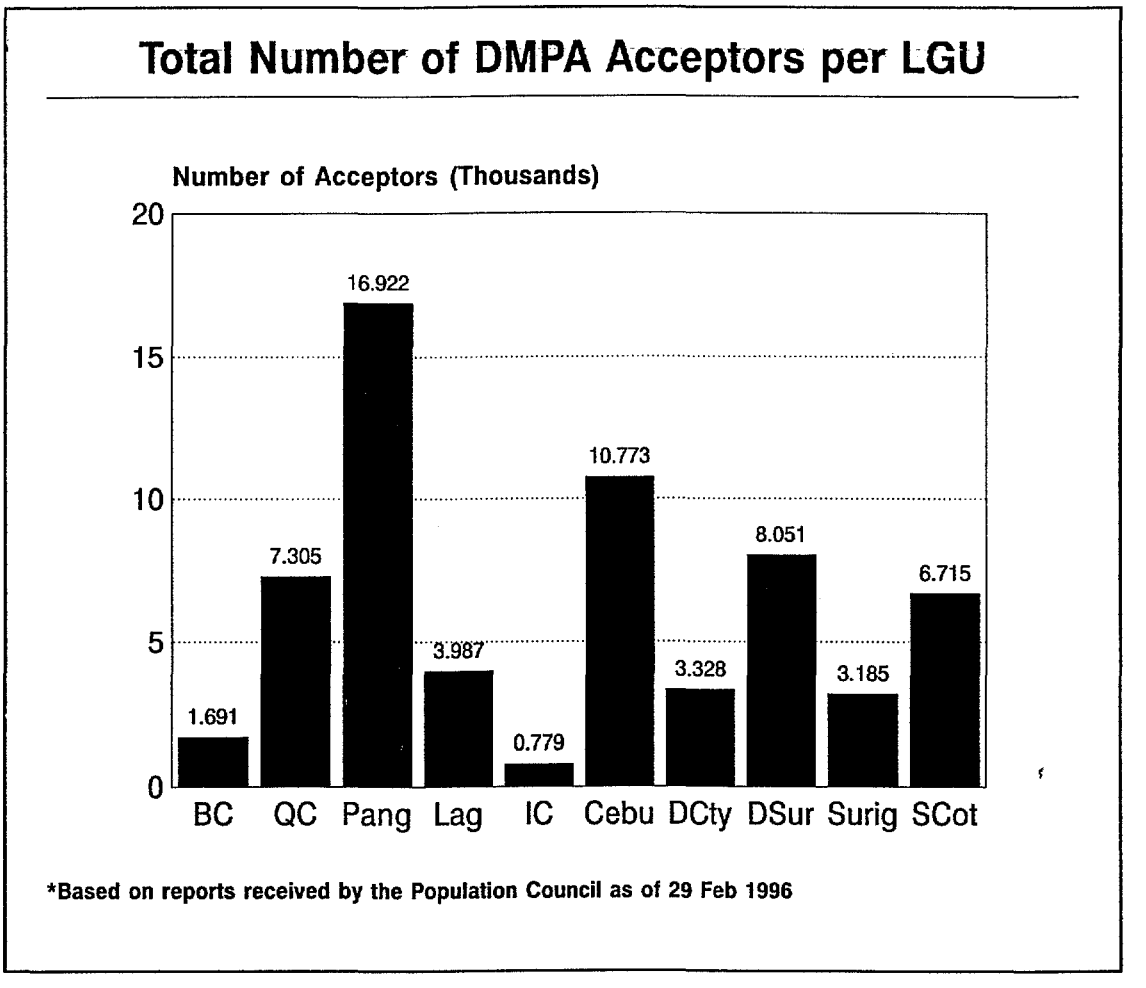
[3]Final Report A (Population Council, Manila, 1995, Figure 32) gives an estimate DMPA acceptors in the ten LGUs (as of June 1995) at approximately 3 percent of all MWRAs.

Figure 11



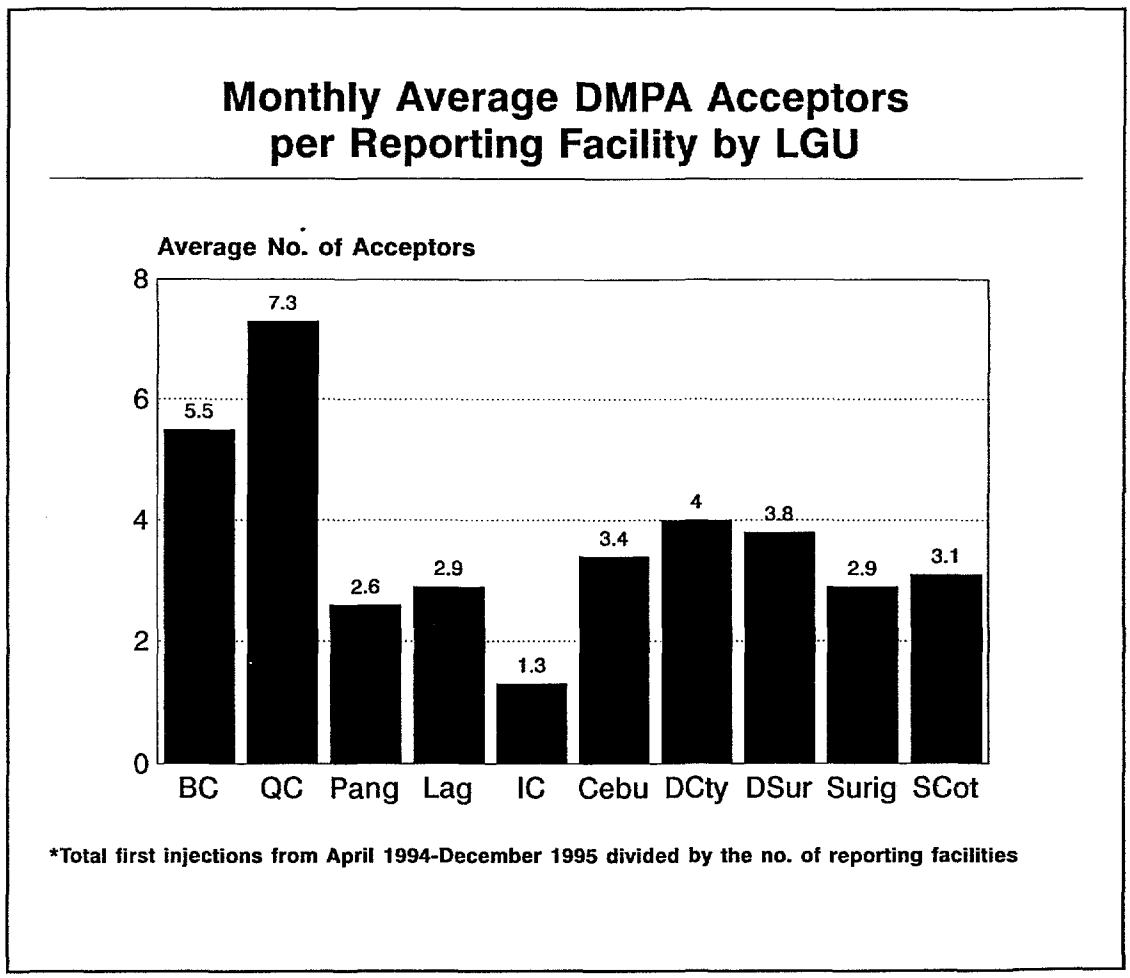
The LGUs which recorded the highest and lowest cumulative total injections dispensed during the twenty one-month observation period were the same ones recording the highest and lowest numbers of DMPA acceptors. Findings show that Pangasinan had the highest cumulative total of DMPA acceptors at 16,922 while Iloilo City turned in the lowest cumulative output with only 779 acceptors during the entire study period (please see Figure 12).

Figure 12



However, while Pangasinan may have had the highest cumulative total in terms of new acceptors enrolled in the program, Figure 13 shows that its average monthly output was only 2.6 acceptors per facility. This was twice higher than Iloilo City which had the lowest average output of 1.3 acceptors per facility per month. Quezon City and Baguio City recorded the highest average number of DMPA acceptors at about 7.3 and 5.5 per facility per month. On the whole, the ten pilot LGUs averaged 3.2 new acceptors per facility per month.

Figure 13

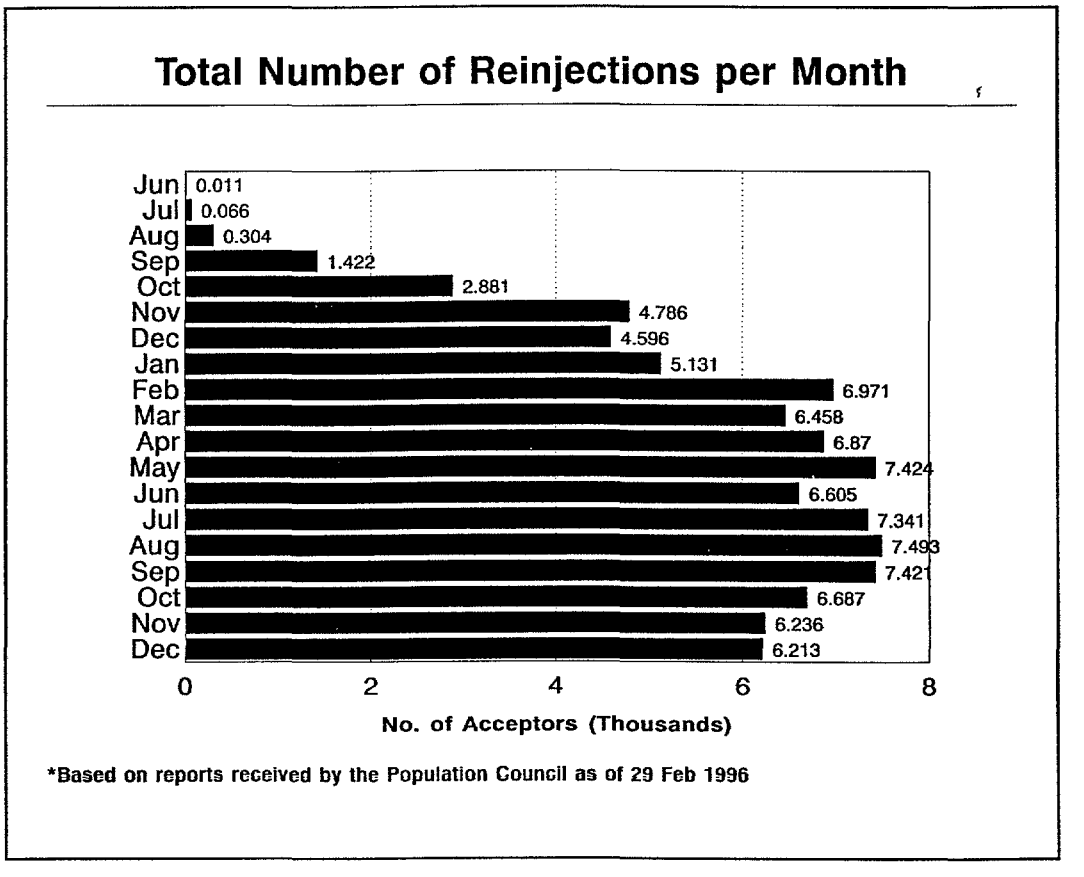


Urban-based DMPA dispensing facilities accounted for about 5 acceptors per facility per month while those in the provinces accounted for 3 acceptors per facility per month .

C. DMPA Reinjections

The total number of reinjections increased significantly from January to September 1995. This increase, which is depicted in Figure 14, is due largely to the inclusion of the third, fourth, and fifth injections at this time. A slight decline in the number of reported reinjections was observed during the last three months of the study (October-December 1995). An analysis of the monthly averages for all reporting facilities, however, shows that in this case the average number of reinjections per reporting facility remained somewhat above average at this time when compared to the study as a whole. The above decline may therefore be attributed to the reduced submission rates experienced at that time.

Figure 14

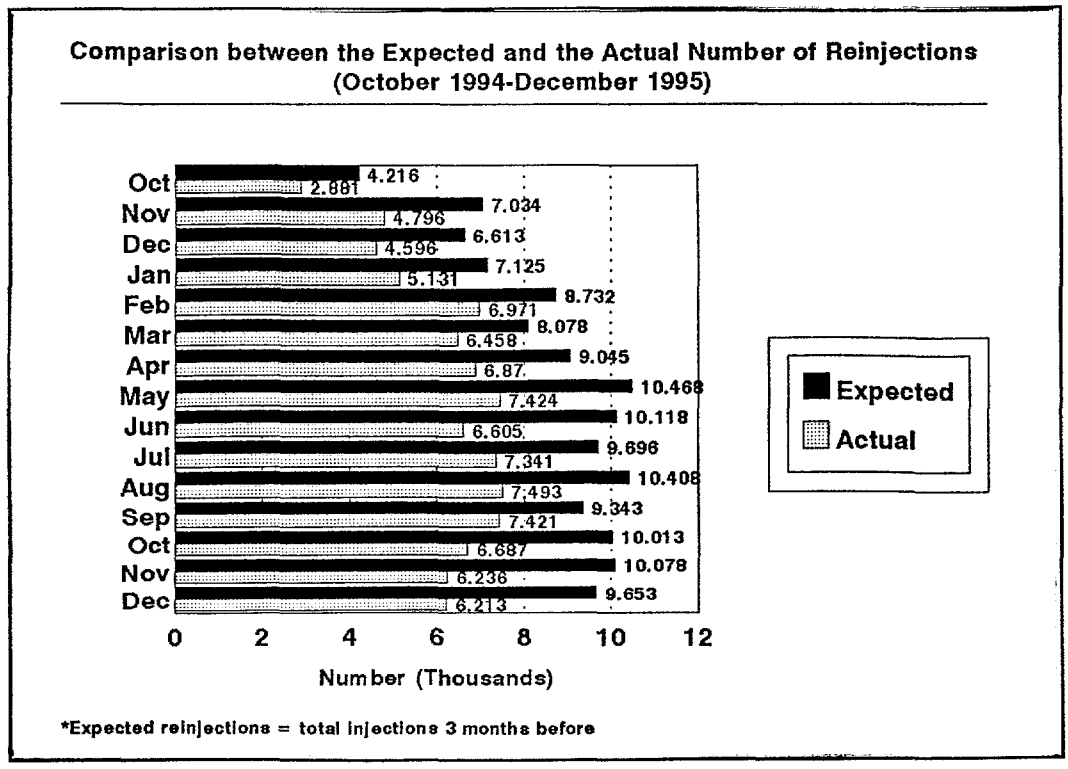


Again, Pangasinan recorded the highest number of reinjections dispensed during the 21-month period while Iloilo City had the lowest. Facilities from the provinces accounted for 80 percent of all DMPA reinjections whereas 20 percent came from city-based facilities. In terms of reinjections per facility per month, though, those from the cities performed slightly better at 6.9 reinjections per facility per month while those from the provinces recorded only 4.6.

D. DMPA Continuation/Reinjection Rates

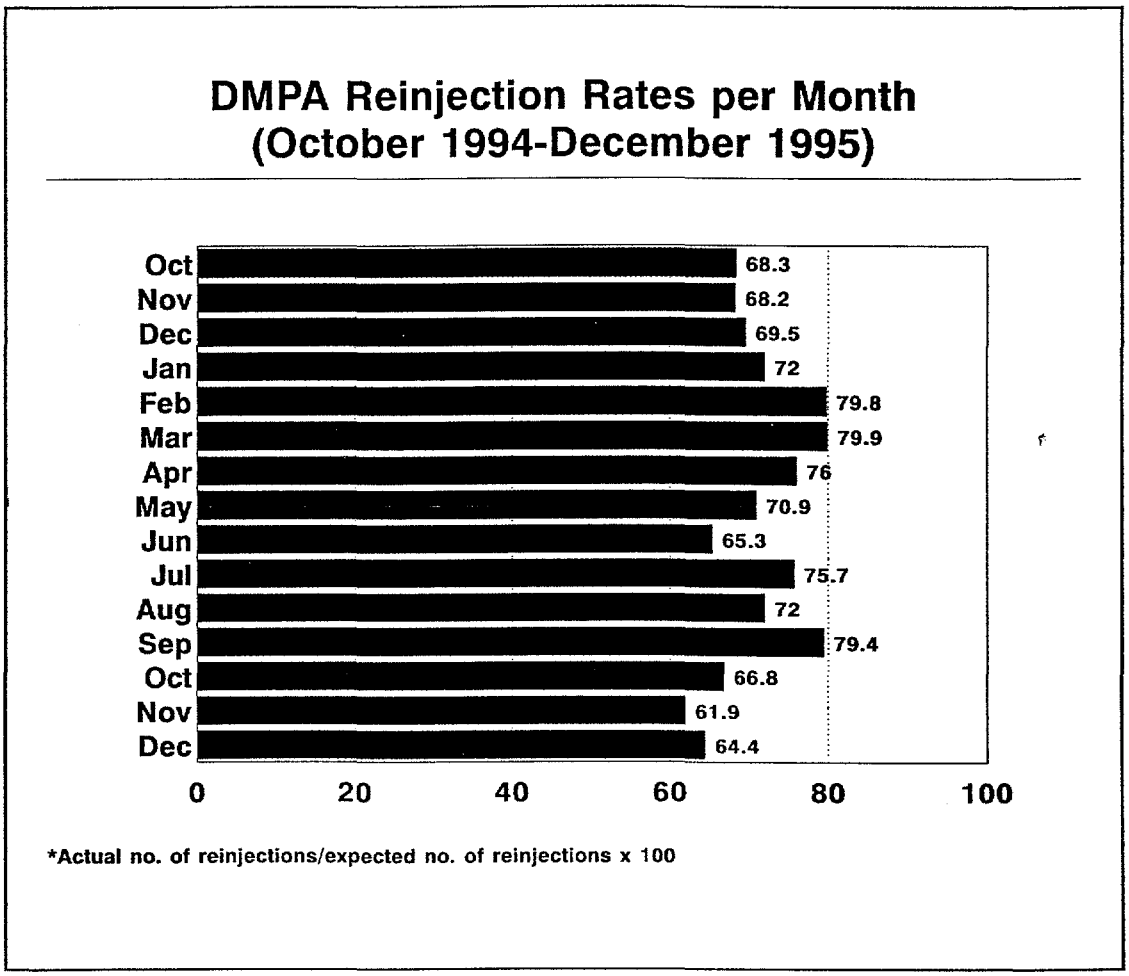
To determine the DMPA continuation/reinjection rate, the actual number of reinjections dispensed during a particular month was compared with the number of reinjections expected to be given at this time. Reinjections included all second, third fourth, fifth and sixth injections. Expected reinjections for a particular month were equivalent to the total number of injections dispensed three months before, while actual reinjections were those recorded for the month in question. Figure 15 shows the comparison between the expected and the actual number of reinjections from October 1994 to December 1995.

Figure 15



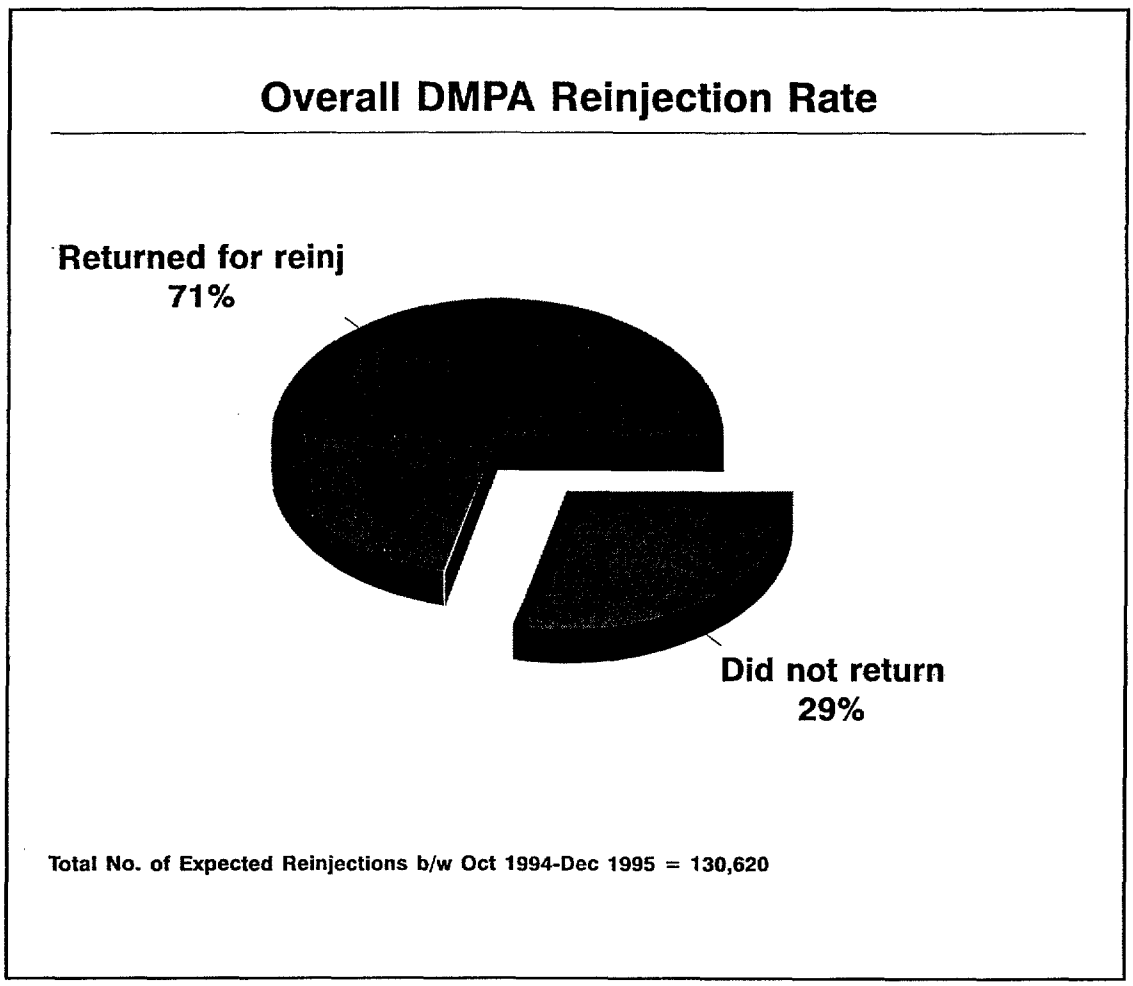
It is shown in Figure 16 that the reinjection rates for October and November 1994 were only a little more than 68 percent. A steady increase in reinjection rates was then observed for the next four months as again followed by a continous decline from April to June 1995. Although reinjection rates improved during the sixth quarter (August to September), these again declined to as low as 61.9 percent during November 1995.

Figure-16



Overall, the DMPA reinjection rate was 71.3 percent as shown in Figure 17. Of the 130,620 reinjections expected to be given between October 1994 to December 1995, a total of only 93,123 reinjections were actually dispensed.

Figure 17



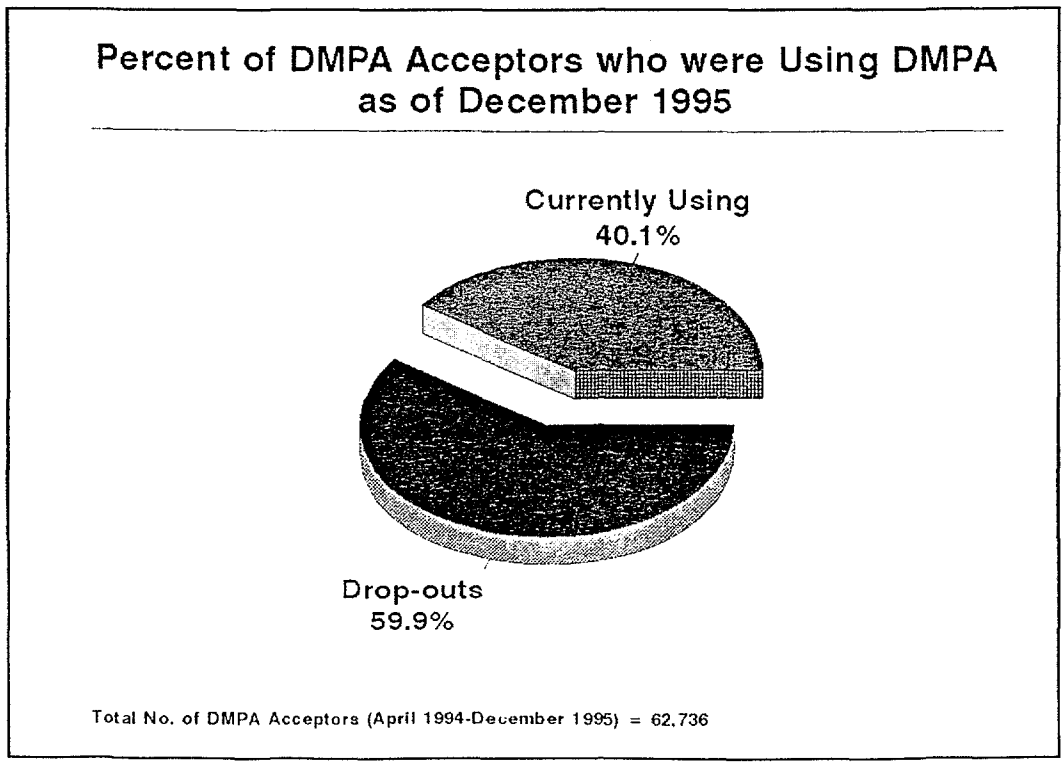
Note however, that this approach to computing the DMPA reinjection rate for each month lumps together the second, third, fourth and fifth injections. Hence, duration of use and reinjection rates per injection could not be ascertained. This particular limitation was due to the fact that the DMPA monitoring form, as originally designed, failed to distinguish among these different durations of use (i.e., first, second, third and fourth reinjection).

E. Current Users of DMPA

The proportion of all DMPA acceptors who were still current users as of the end of this study's observation period was computed by adding the number of new acceptors (first injections) and reinjections as of December 1995 to the number of new and returning acceptors (total injections) for the two previous months. Given that the effectivity of DMPA lasts for three months, women who have been injected (or reinjected) during the preceding two months were also included. By comparing the number of current users at the end of the observation period with the total number of DMPA acceptors recorded throughout the entire study period, the percentage of all acceptors who were still using this FP method can be ascertained.

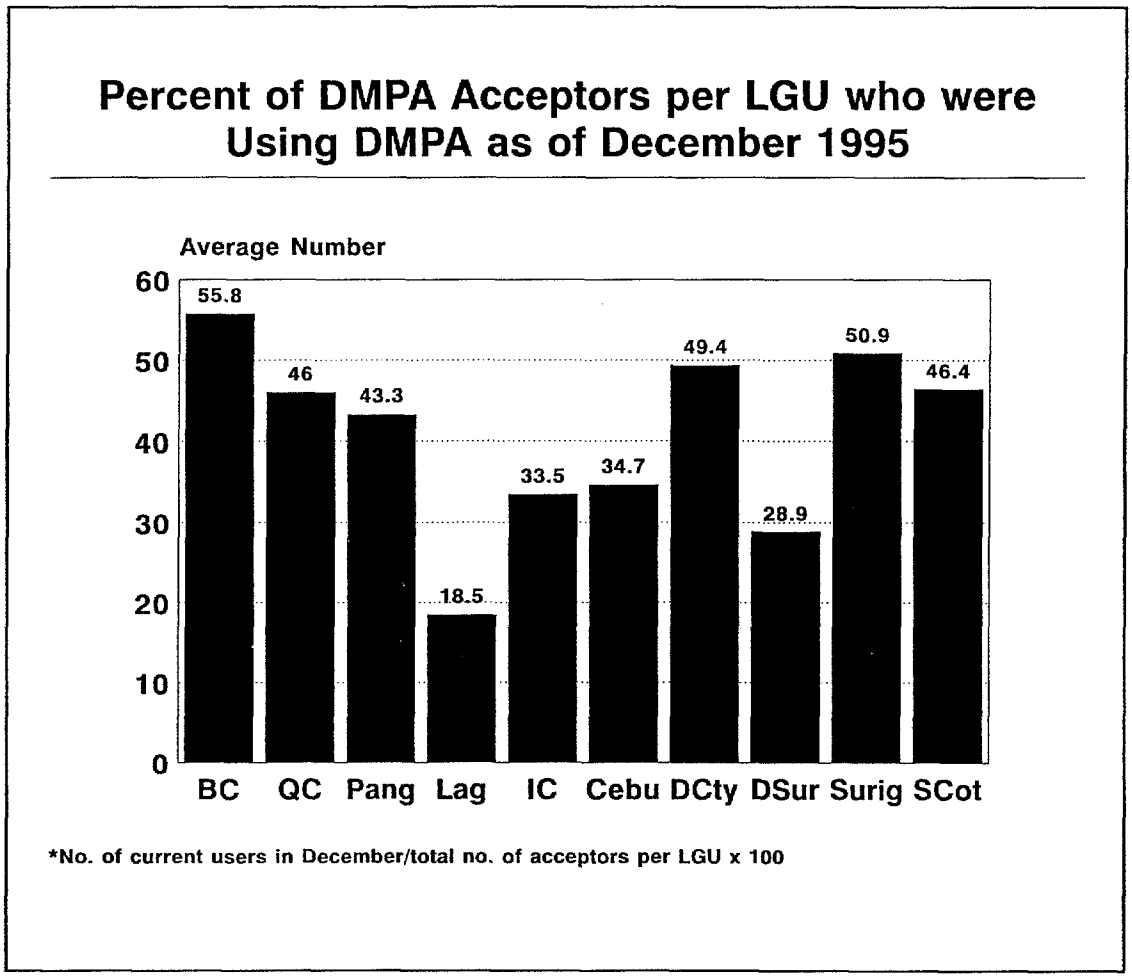
Data in Figure 18 show that, of the 62,736 DMPA acceptors in the ten pilot LGUs, only 25,175 were still using DMPA as of December 31, 1995. The overall proportion of current users is therefore about 40 percent.

Figure 18



Current user rates varied per LGU. As shown in Figure 19, Baguio City showed the highest current user rate. Notice, however, that the low reporting LGUs -- specifically Laguna, Davao Sur and Cebu -- also recored low current user rates. It is therefore likely that these estimates have been adversely affected by the data retrieval problem discussed earlier.

Figure 19



F. Contribution of the Initial Implementation of the DMPA Reintroduction Program to the Philippine FP Program

In this section we present data on the proportion of all MWRAs who adopted DMPA so as to give some indication of the "impact" of the first phase of the DMPA reintroduction program to the national FP program. At first glance, this would as yet appear to be relatively minor. Data in Figures 20 and 21 thus show that, of the estimated 1.9 million MWRA in the ten pilot LGUs, only 3.3 percent had accepted DMPA during the observation period whereas an even smaller proportion (about 1.4 percent) were still using it as their FP method as of December 1995.

It should be noted that prior to the DMPA reintroduction program, only one-tenth of 1 percent (0.1 percent) of all Philippine women of reproductive age were using DMPA. In that sense the current user level of 1.4 percent does show a definite, though minimal, program impact, at least as far as the pilot LGUs are concerned. It would appear in fact that the program was able to increase the level of injectable use by about 1.3 percent.

In a follow-up survey of approximately 900 DMPA acceptors from nine of the pilot LGUs, Patron and Palabrica-Costello (1995, Table 7a) found that 27.3 percent of DMPA acceptors had never previously used any other form of FP. As a minimum estimate, therefore, we can say that the reintroduction program increased the current level of FP use in the pilot LGUs by approximately 0.4 percent.[4]

[4]That is, we are assuming in this case that 27.3 percent of DMPA acceptors would not be using FP as of December 31, 1995 because they were not favorable towards any method other than DMPA. We thus multiply 1.4 percent by .273 and get .003822, which rounds to 0.4 percent. Note that this is probably an underestimate since it ignores the contribution made by DMPA towards attracting FP dropouts (i.e., those past users of some other method who were not using any method when they decided to have their first DMPA injection) back to the program.

Figure 20

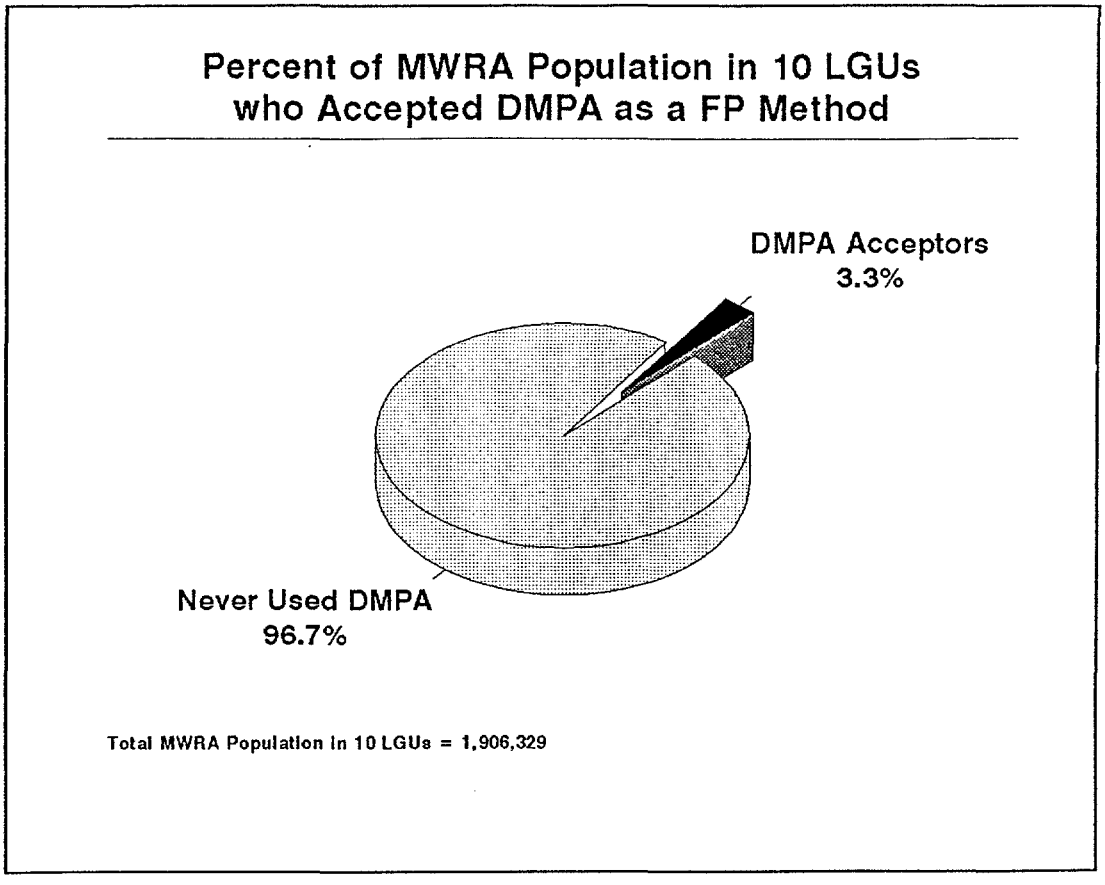
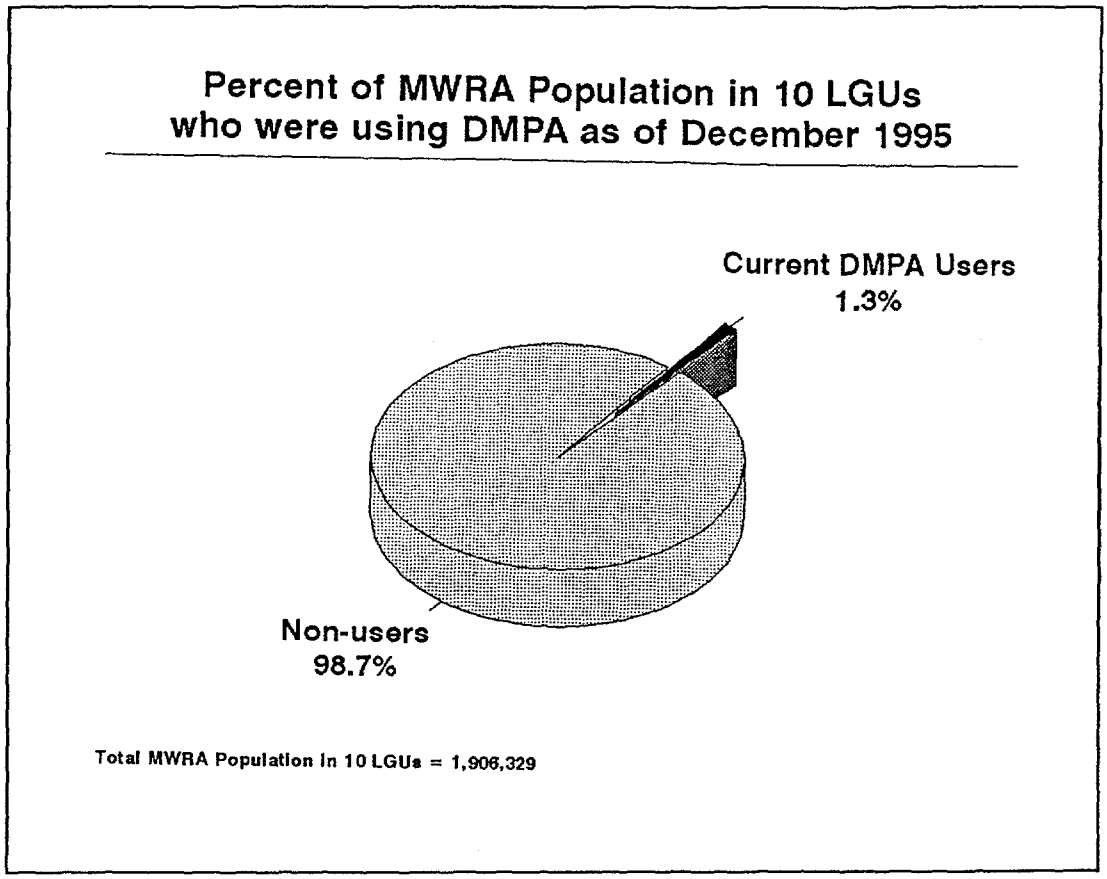

Percent of MWRA Population in 10 LGUs
who Accepted DMPA as a FP Method
DMPA Acceptors
3.3%
Never Used DMPA
96.7%
Total MWRA Population in 10 LGUs = 1,906,329

Figure 21

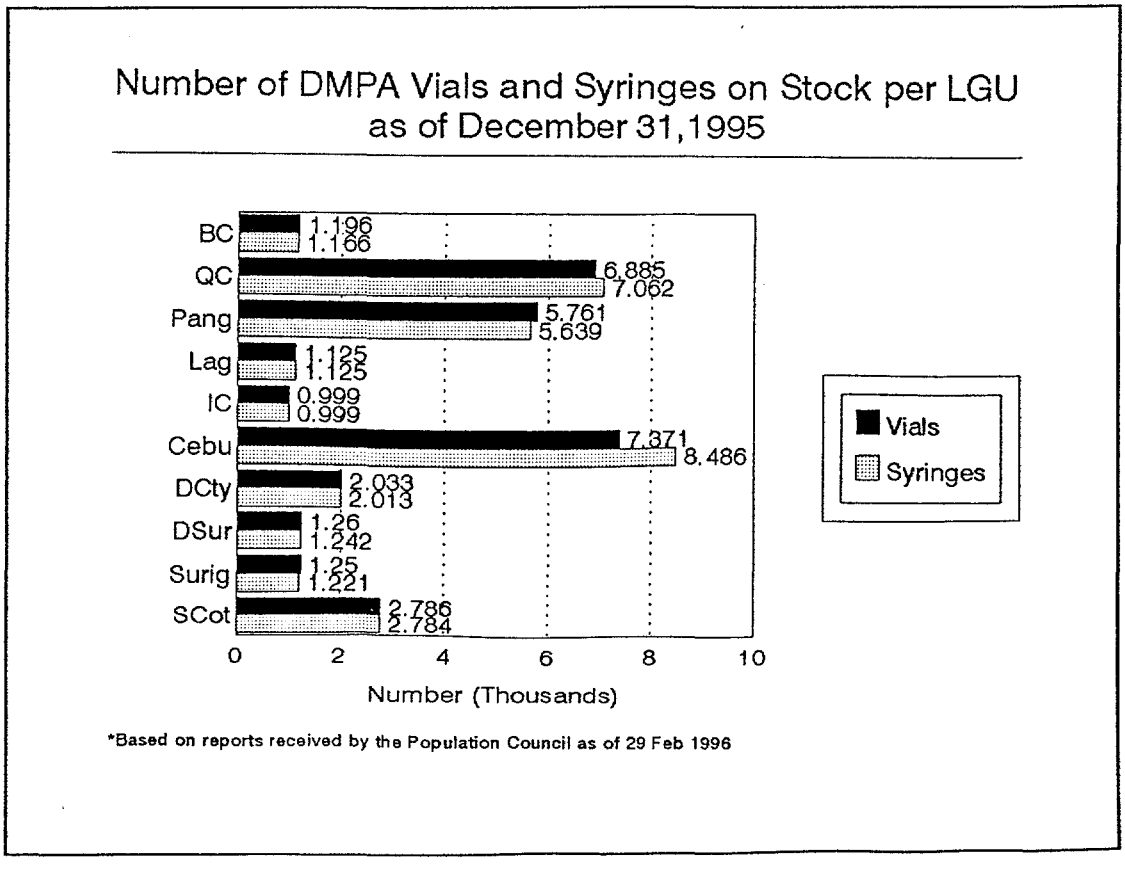

Percent of MWRA Population in 10 LGUs
who were using DMPA as of December 1995
Current DMPA Users
1.3%
Non-users
98.7%
Total MWRA Population in 10 LGUs = 1,906,329

G. Availability of DMPA Supplies

The study also monitored the availability of DMPA vials, syringes and needles at the health facilities covered by Phase I of the reintroduction program. Using the DMPA monitoring form, service providers were asked to log the remaining stock of vials, syringes and needles in the facility as of the end of each reporting month. This information may be used in order to determine if there is an adequate stock in the facility for the next three to six months as well as to see if there are discrepancies in the number of vials vis-a-vis syringes and needles.

As of December 31, 1995, there was still a total of 30,666 vials and 30,737 syringes/needles in the health facilities which submitted a report on this. This represents an average stock of 36 DMPA vials and 36 syringes/needles per reporting health facility.

Figure 22



The greatest numbers of unused vials and syringes were generally found in the larger LGUs, e.g. Cebu, Quezon City and Pangasinan (Figure 22). In comparison, Figure 23 shows that the greatest numbers of vials/syringes on a per facility basis were found in Quezon City, Cebu and Baguio, all with 70 or more per facility. Davao del Sur, Pangasinan and Surigao del Sur all fared more poorly in this regard with averages of less than 20 vials/syringes per facilty. These figures also demonstrate that discrepancies in the average number of vials vis-a-vis the number of syringes/needles were generally negligible. This would appear to indicate that the DMPA syringes and needles are not being used for purposes other than that for which they had been originally intended.

Figure 23

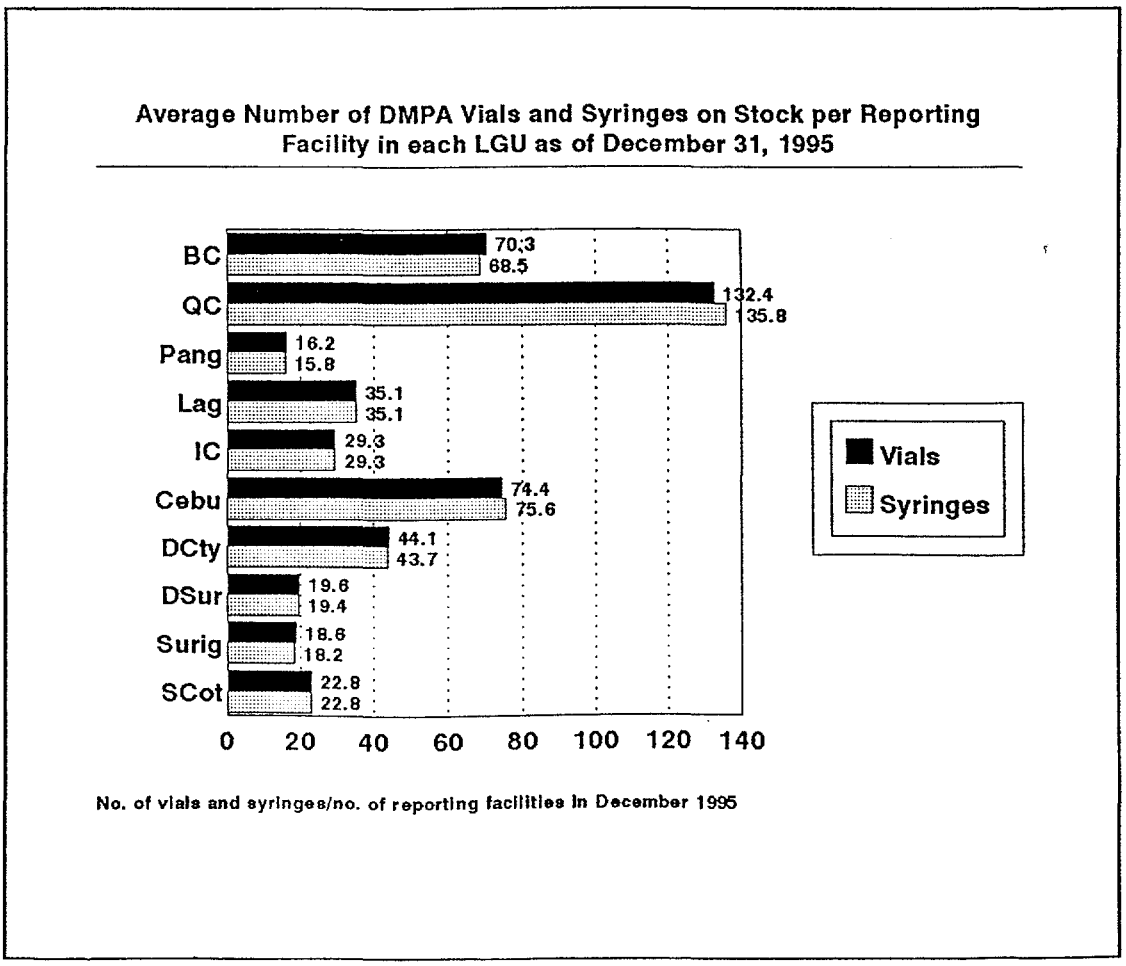
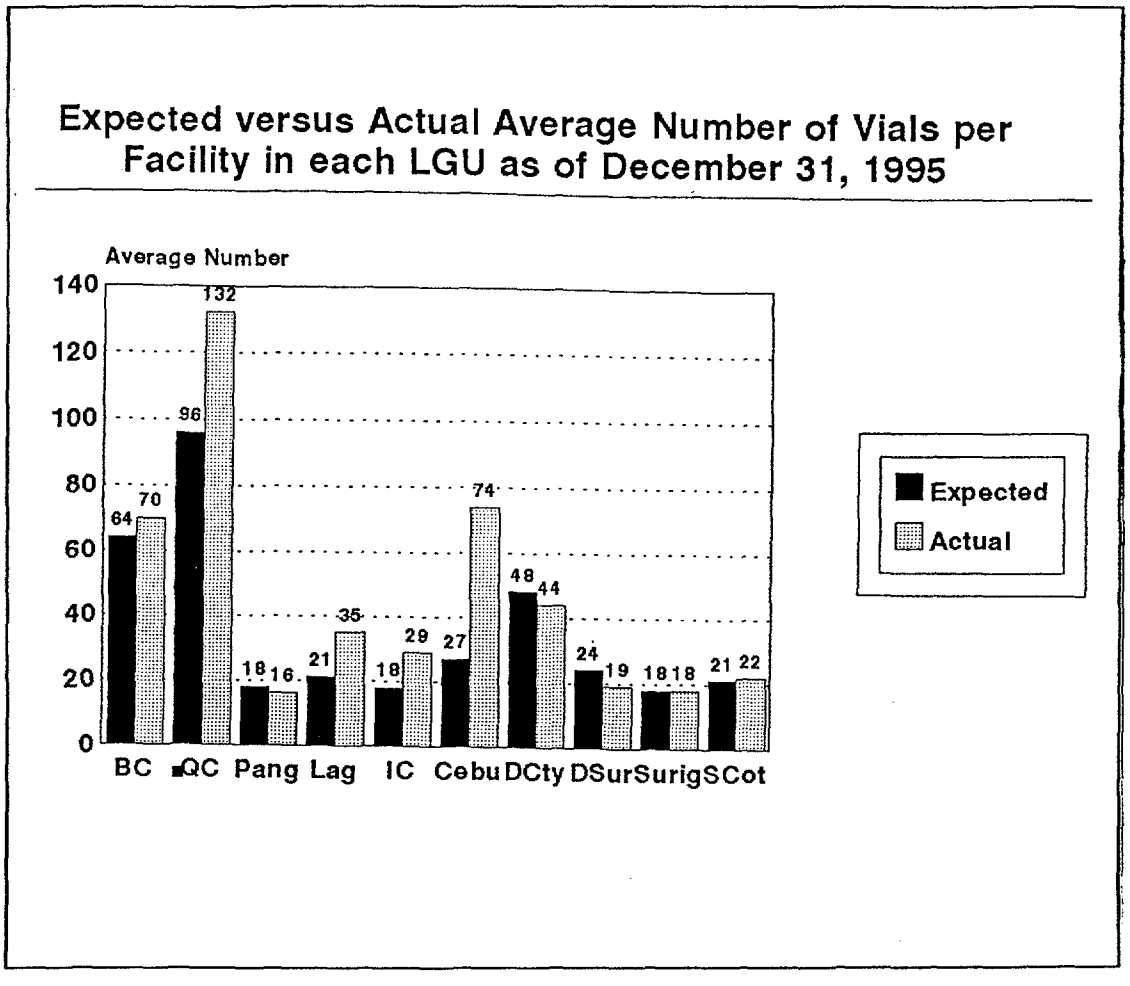


Figure 24



The reported number of average stocks per facility in each LGU was compared to the number of stocks which the LGU is expected to maintain by the DOH (i.e. the minimum number of vials needed to service the local area population). Figure 24 shows the result of this comparison and indicates that most of the LGUs had an adequate supply of DMPA vials as of December 31, 1995. Supply shortages, however, could be noted in Pangasinan, Davao City and Davao Sur.

H. Availability of DMPA IEC Materials

The study also monitored the availability of IEC materials, particularly the presence of DMPA reminder cards and leaflets in the pilot facilities. These data are presented in Figures 25 and 26.

Figure 25

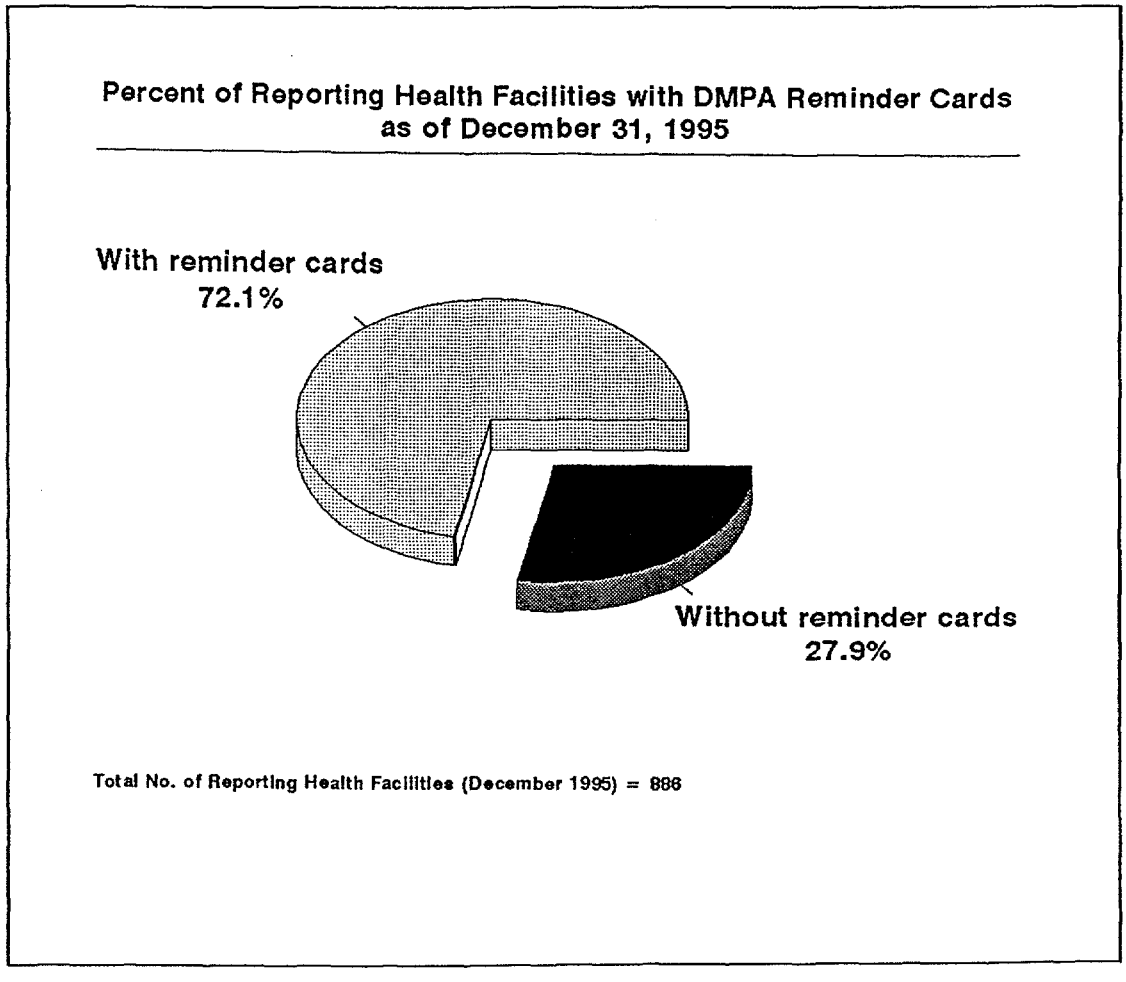
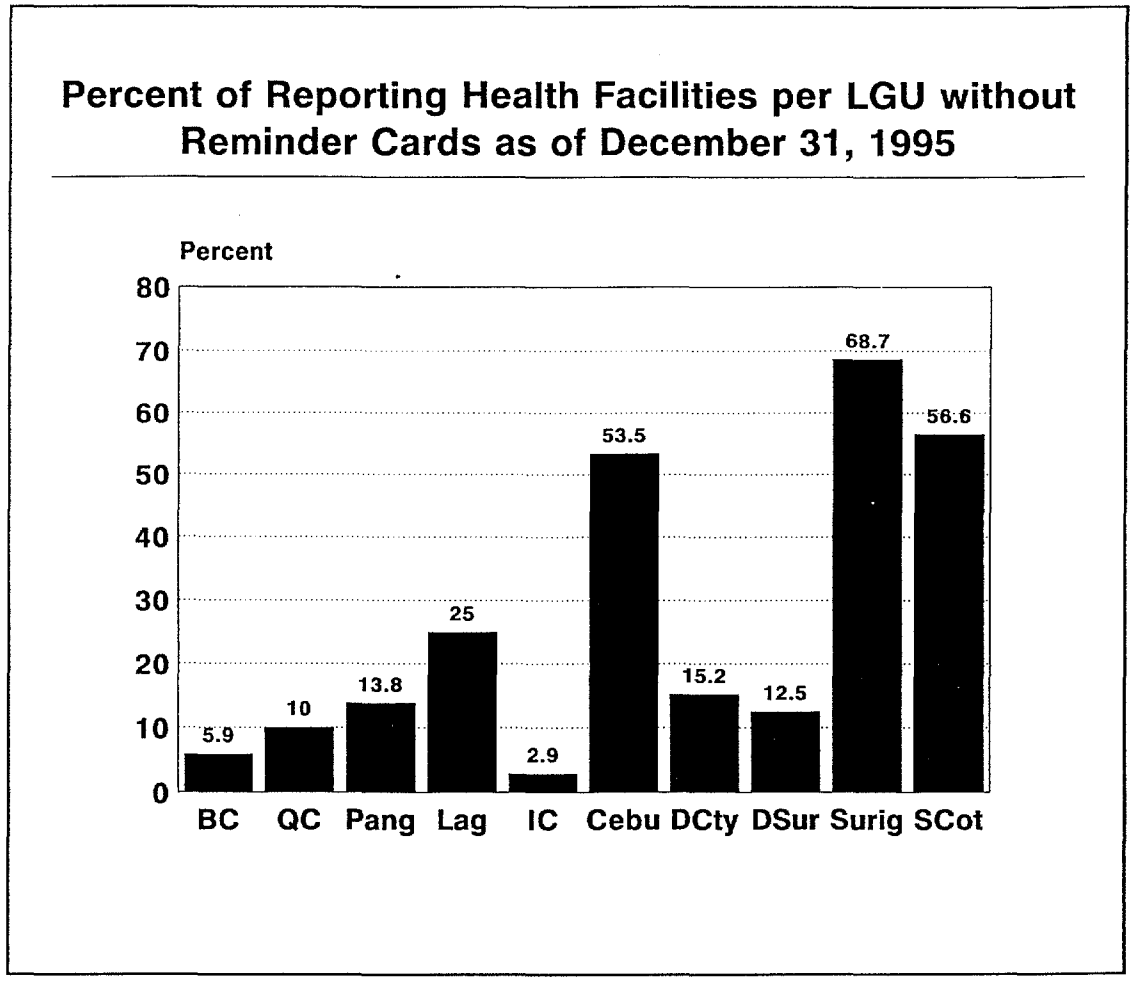


Figure 26



As of 31 December 1995, 27.9 percent of the reporting facilities no longer had any reminder cards. LGUs which experienced a widespread shortage of reminder cards included Surigao Sur (68.7%), South Cotabato (56.6%) and Cebu (53.5%).

Figures 27 and 28 indicate that shortages of DMPA leaflets were also experienced by a large proportion of the health facilities. As of 31 December 1995, 30.8 percent of the reporting health facilities no longer had any such materials. Shortages of DMPA leaflets were most pronounced in Baguio City, Surigao Sur, Iloilo City and South Cotabato.

Figure 27

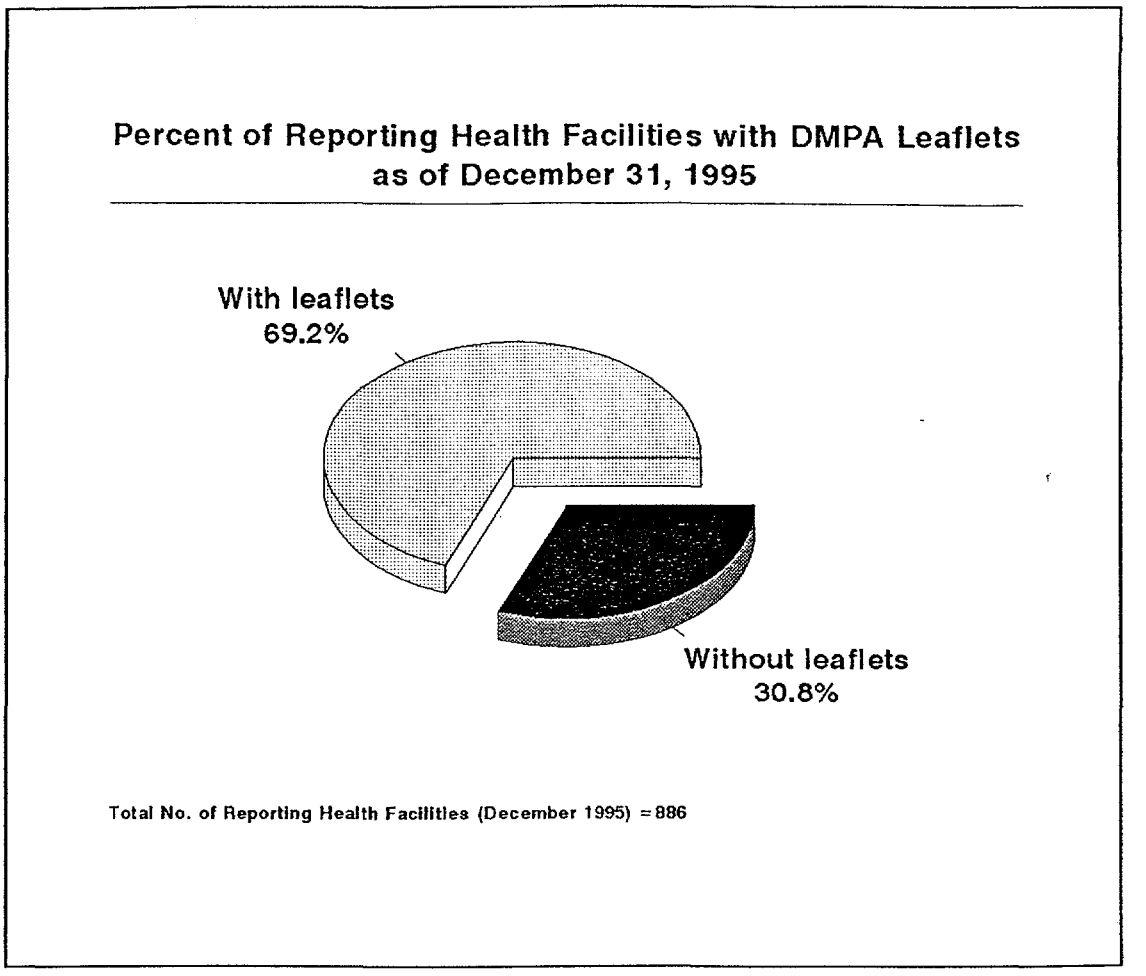
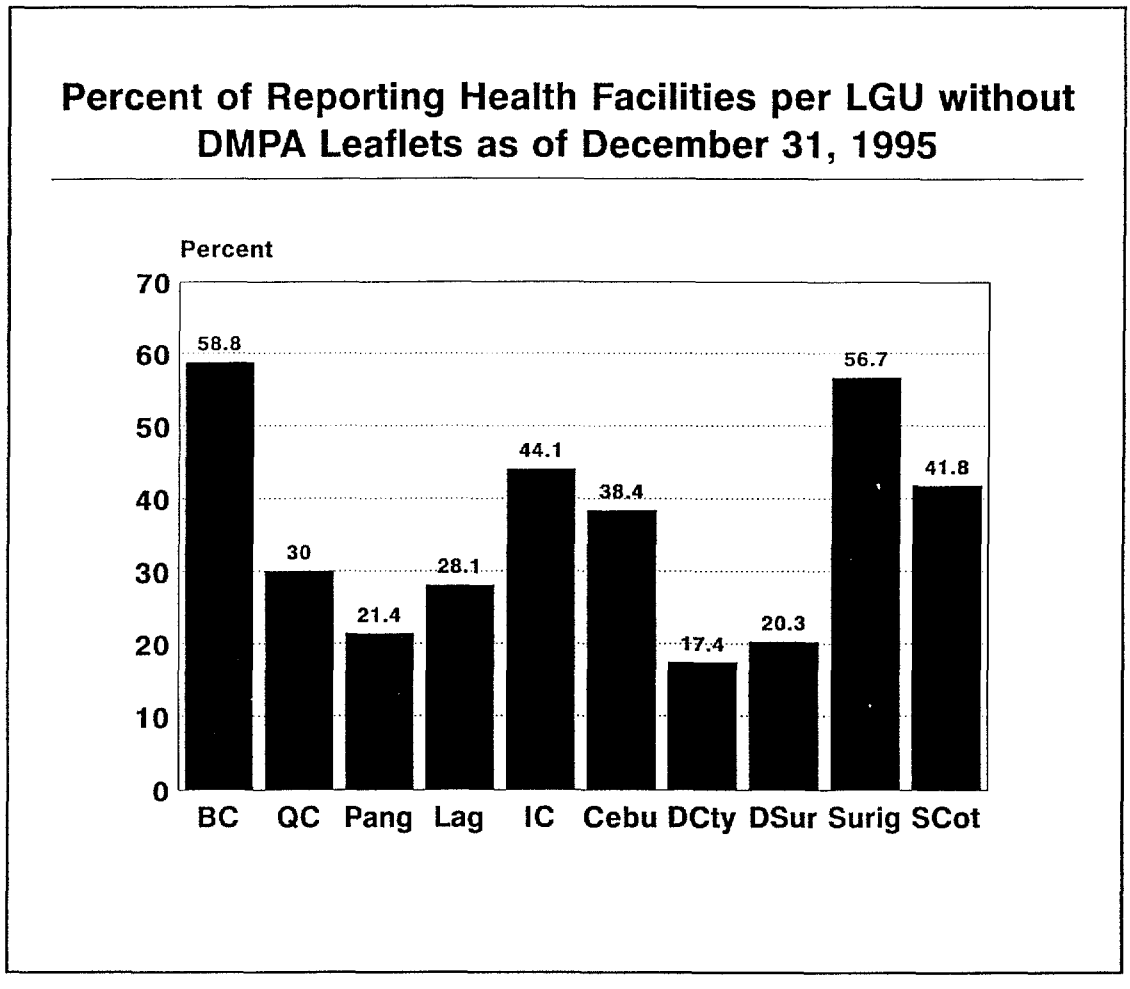


Figure 28



These findings demonstrate that there is a need to improve the existing system for distributing IEC materials about DMPA to the local level. In particular, DMPA reminder cards should be made available in all DMPA-dispensing facilities in order to help women remember when their next reinjection is due. An adequate number of leaflets should likewise be found in the facilities so as to assist in the campaign to recruit a greater number of DMPA acceptors.

Shortages in IEC materials were generally small in the LGUs located closest to Metro Manila (Quezon City, Pangasinan, Laguna) whereas they tended to be high in peripheral areas like Surigao and South Cotabato. This indicates that special attention may have to be given to facilitating the flow of these materials to the less accessible LGUs.

I. Number of First Injections and Reinjections: Pro-Rating Results

We have noted that the reported decrease in the number of first injections and reinjections, specifically during the last six months of the observation period, has been affected by the decline in the reporting rates of most of the LGUs. This being the case, it will therefore be necessary to adjust for this factor if we are to come up with an overall estimate of the number of first injections and reinjections. This may be accomplished by a pro-rating exercise which assumes that those facilities which did not file their monitoring report were nonetheless equally active in dispensing DMPA as those that did submit the report (i.e., the method takes the average number of injections and reinjections per facility for the reporting facilities and applies this as well to all facilities which failed to submit their report).

Pro-rating of the number of injections was not carried out for all months prior to July 1994, since it was only by then that the trainings for the service providers were more or less completed. The months July '94 - September '94 thereby become Quarter 1, whereas October '94 - December '94 is Quarter 2, January '95 - March '95 is Quarter 3, April '95 - June '95 is Quarter 4, July '95 - September '95 is Quarter 5 and October '95 - December '95 is Quarter 6.

The pro-rated number of first injections shown in Table 1 show a pattern similar to that discussed earlier; i.e., that most LGUs have experienced a long-term decline in DMPA acceptance. This was especially true for Pangasinan and South Cotabato, which registered first injection levels during the Sixth Quarter that were less than half as large

as those obtained during the First Quarter. In comparison, proportionate declines between these same two quarters were least for the three remaining LGUs from Mindanao -- Davao City, Davao del Sur and Surigao del Sur.

Table 1. Total Number of First Injections per Quarter by LGU (Pro-rated)

	Q1	Q2	Q3	Q4	Q5	Q6
Baguio City	470	309	226	239	205	251
Quezon City	1,735	1,165	1,288	1,025	1,102	952
Pangasinan	4,980	3,716	3,255	2,618	2,129	1,930
Laguna	1,233	906	1,118	926	757	668
Iloilo City	164	173	216	92	67	88
Cebu	3,159	2,478	2,571	2,034	1,094	1,725
Davao City	583	579	681	628	537	510
Davao Sur	2,427	1,768	1,780	1,393	1,459	2,400
Surigao Sur	590	661	591	563	617	575
South Cotabato	1,938	1,246	1,372	1,090	871	854
All LGUs	17,279	13,001	13,098	10,578	9,648	9,953

Table 2 shows the number of reinjections as computed by the same pro-rating procedure. As may be seen therein, Quezon City, Davao City and Surigao Sur all showed consistently increasing trends. Most of the other LGUs also experienced an upward movement although declines can be noted between the Fifth and Sixth Quarters in several cases. Laguna and Iloilo City are perhaps the most problematic in this regard since these show declines for two succeeding quarters over the period July to December 1995.

Table 2. Total Number of Reinjections per Quarter by LGU (Pro-rated)

	Q1	Q2	Q3	Q4	Q5	Q6
Baguio City	75	380	634	618	725	692
Quezon City	175	1,226	1,785	2,350	2,416	2,934
Pangasinan	397	3,646	6,260	6,285	7,113	6,732
Laguna	307	1,040	1,561	2,421	2,330	2,110
Iloilo City	24	138	272	280	269	196
Cebu	406	2,978	5,126	6,158	6,755	6,583
Davao City	5	469	733	1,084	1,170	1,264
Davao Sur	400	2,003	3,128	3,902	4,315	3,696
Surigao Sur	3	371	705	1,015	1,266	1,463
South Cotabato	153	1,506	1,930	2,301	2,545	2,535
All LGUs	1,945	13,757	22,134	26,414	28,904	28,205

From the pro-rated number of first injections and reinjections, the average number of injections dispensed per facility in each LGU was also ascertained. Table 3 shows these figures. As may be noted therein, at least four LGUs (Baguio City, Quezon City, Davao City, and Surigao del Sur) showed generally increasing trends. In comparison, stable or declining rates can be noted for Iloilo, Laguna, Pangasinan, Cebu, Davao Sur and South Cotabato. Iloilo City and Laguna posted the highest declines from the fourth to the last quarter with the average number of injections in these two LGUs going down by 23.6 percent and 17.6 percent, respectively, at this time.

The relatively poor performance noted on several of the indicators used in this study for Laguna and Iloilo City is worthy of further comment, speculative as this may be. In the former case it may be hypothesized that a lack of political support for the FP program as a whole has weakened the DMPA reintroduction effort (the governor of Laguna is a well-known critic of "artificial" forms of contraception). In Iloilo City, in contrast, the major problem may be the presence of a medical/legal barrier in the form of a local stipulation that husbands must sign a consent form before a married woman can be injected with DMPA.

Table 3. Average Number of Monthly Injections Dispensed per Facility by LGU*

	Q1	Q2	Q3	Q4	Q5	Q6
Baguio City	10.69	13.51	16.86	16.80	18.24	18.49
Quezon City	12.32	14.49	18.18	19.74	20.57	22.73
Pangasinan	5.23	6.15	7.62	6.86	7.08	6.64
Laguna	6.70	6.64	6.73	7.44	6.81	6.13
Iloilo City	2.11	3.08	4.52	3.35	3.03	2.56
Cebu	6.15	7.73	10.49	10.89	11.45	10.99
Davao City	4.29	7.28	9.43	11.41	11.38	11.83
Davao Sur	6.20	8.36	10.18	10.83	11.81	12.37
Surigao Sur	6.05	5.61	5.40	6.39	7.56	8.18
South Cotabato	5.58	7.28	8.53	8.48	8.50	8.43
All LGUs	6.03	7.34	8.93	8.98	9.36	9.11

* based on pro-rated results

PROJECTED DMPA UTILIZATION BASED ON THE STUDY RESULTS

The observed data on the average monthly total injections from July 1994 to December 1995 were compared to several theoretical models as a preliminary step towards projecting the demand for DMPA from July 1995 to December 1998. In this regard, three criteria were considered in deciding on which model to use in forecasting the DMPA demand:

1. The model should explain or account for at least 80.0 per cent of the variation in the observed data;

2. All the independent variables in the model should be significant, i. e., all b coefficients are significantly greater than zero; and

3. The projected values do not go far beyond the range of the observed data.

A. The Models

There were seven models examined to determine initially which model best fit the observed data on the average number of injections per month. These were (1) the Simple Arithmetic Expansion Model, (2) the Simple Time Series Model, (3) the Lagged Model, (4) the Sinusoidal Model, (5) the Learning Curve Model, (6) the Learning Curve Cum Lagged Model, and (7) the Learning Curve Cum Sinusoidal Model.

1. Model I: Simple Arithmetic Expansion Model

This model is expressed as follows:

$Y_i = Y_i'$

where: Y_i = Average Monthly Total Injections

Y_i' = Weighted Average of Monthly Total Injections

= 8.30

Model I essentially assumes that there will be no change in DMPA injection levels throughout the period in question. It was already used in Feb 1995 to forecast DMPA requirements for 1995-1998. This was resorted to because of the limited data available at that time on total injections. This model is not expected to give a good fit to the data and is being shown for comparison with the other models.

2. Model II: Simple Time Series Model

This Model is as follows:

$Y_i = a + bX_i + e_i$

where: Y_i = Average Monthly Total Injections

X_i = Month:1, Jul '94;2, Aug, '94;..;18, Dec '95

e_i = error

This model makes use of time (as measured by the ordinal ranking of the months in question) as a predictor of average monthly total injections. As this is a simple linear regression model, the extent to which the model explains the variation in the data is measurable. It has a standard deviation of 0.80, which is a measurement of how far the model is from the actual data. The "b" coefficient is significantly greater than zero, i.e., the passage of time significantly explains the monthly pattern of total injections. The Coefficient of Determination (R^2) is 67.09 percent which means that the model accounts for 67.09 per cent of the variation of the data.

3. Model III: Lagged Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + e_i$$

where: Y_i = Average Monthly Total Injections

X_{1i} = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

X_{2i} = Average Monthly Total Injections 3 Months Earlier

This model is Model II plus another variable, X_2, the average number of injections three months earlier. This additional term in the model captures the phenomenon of women who have had their DMPA injections 3 months earlier returning for their reinjections. In this case only X_1, (i.e. month) is significantly related to Y, the average monthly total injections. This model has a standard deviation of 0.57 and explains 84.44 per cent of the variation of the data on average monthly total injections.

4. Model IV: Sinusoidal Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + b_5X_{5i} + e_i$$

where: Y_i = Average Monthly Total Injections

X_{1i} = t, Month: 1, Jul '94;2, Aug '94;..;18, Dec '95

$X_{2i} = \text{Cos}\ (2\pi t/3)$

$X_{3i} = \text{Sin}\ (2\pi t/3)$

$X_{4i} = t\ \text{Cos}\ (2\pi t/3)$

$X_{5i} = t\ \text{Sin}\ (2\pi t/3)$

This model consist of the time variable X_1 and four variables with sine or cosine terms, X_2, X_3, X_4, and X_5, which mathematically capture into the model the cyclical phenomenon of women who have taken DMPA injections in a particular month coming back for reinjections in the 4th month or after the 3rd month. However, we again find in this case that only the time variable, X_1, is found to be significantly related to Y. The other four variables are not. This model has a standard deviation of 0.75 and explains 78.60 per cent of the variation in Y.

5. Model V: Learning Curve Model

$$Y_i = a + b(1 - 1/e^t) + \text{error}$$

where: Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

In this model the variable time, t, was transformed by the expression, $(1-1/e^t)$. This makes the effect of time on Y increasing during the initial time periods and then plateauing to a certain level after some time, thus the name Learning Curve Model. In the previous four models, Models I-IV, the effect of time on Y was always increasing. The major predictor variable in this model (time transformed) turned out to be significantly related to Y. The model has a standard deviation of 0.90 and accounts for 58.99 per cent of the variation in Y.

6. Model VI: Learning Curve Cum Lagged Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + e_i$$

where: Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

$X_{1i} = (1 - 1/e^t)$

X_{2i} = Average Total Injections 3 Months Earlier

This model incorporates to the Learning Curve Model within variable X_1, whereas the variable X_2 captures the phenomenon of women coming back for reinjections 3 months after their latest injections. Both variables were found to be significantly related to Y. The model has a standard deviation of 0.54 and accounts for 85.91 per cent of the variation in Y.

7. Model VII: Learning Curve Cum Sinusoidal Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + b_5X_{5i} + e_i$$

where: Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

$X_{1i} = (1 - 1/e^t)$

$X_{2i} = \text{Cos}\ (2\pi t/3)$

$X_{3i} = \text{Sin}\ (2\pi t/3)$

$X_{4i} = t\ \text{Cos}\ (2\pi t/3)$

$X_{5i} = t\ \text{Sin}\ (2\pi t/3)$

This model is similar to Model IV, the Sinusoidal Model except that the time variable, t, was transformed into the variable X_1 through the expression $(1 - 1/e^t)$. It again turns out, though, that only this variable is significantly related to Y. This model has a standard deviation of 0.93 and explains 66.65 per cent of the variation in Y.

The graphical representation of the models for mean total injections per facility are shown in Figures 29, to 35. Their major parameters (standard deviation, coefficient of determination or R^2, significant independent variables, and the F-Ratio for each model) are shown in Table 4.

Table 4. Standard Deviation, R^2, Number of Independent Variables, Significant Variables and F-Ratio for Seven Models of DMPA Demand

INTEGRATED MODELS: TOTAL INJECTIONS	Std Dev	R^2	No. of Independent Variables	Significant Variables	F-Ratio
I. Simple Arithmetic Expansion					
II. Simple Time Series	0.8058	67.09	1	X	32.6106 **
III. Lagged	0.5721	84.44	2	X1	40.7106 **
IV. Sinusoidal	0.7501	78.60	5	X1	37.6253 **
V. Learning Curve	0.8993	58.99	1	X	23.0189 **
VI. Learning Cum Lagged	0.5445	85.91	2	X1, X2	45.7275 **
VII. Learning Curve Cum Sinusoidal	0.9365	66.65	5	X1	4.7970 *

NOTE: * Significant (at 0.05 level)
** Highly Significant (at 0.01 level)

B. The Forecast

Forecasts were made of the average monthly DMPA requirements of Phases I to III using the integrated models. These are shown in Figures 36, 37 and 38. The details are shown in Appendix A.

Figure 29

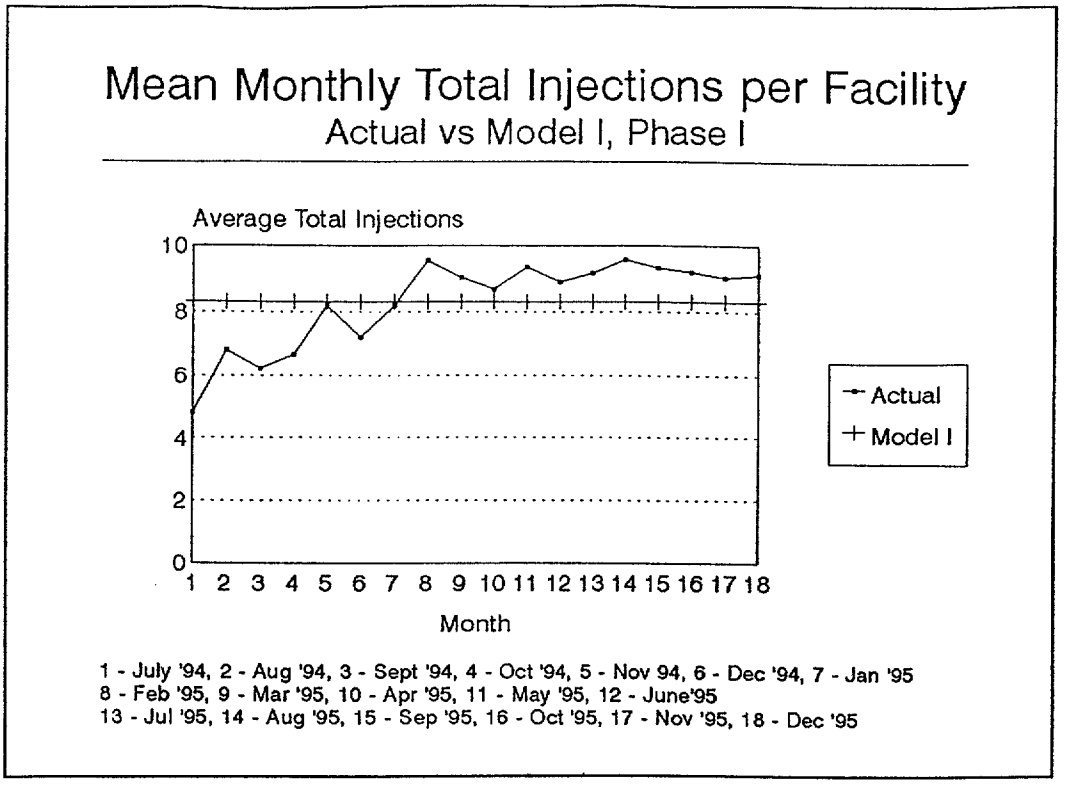


Figure 30

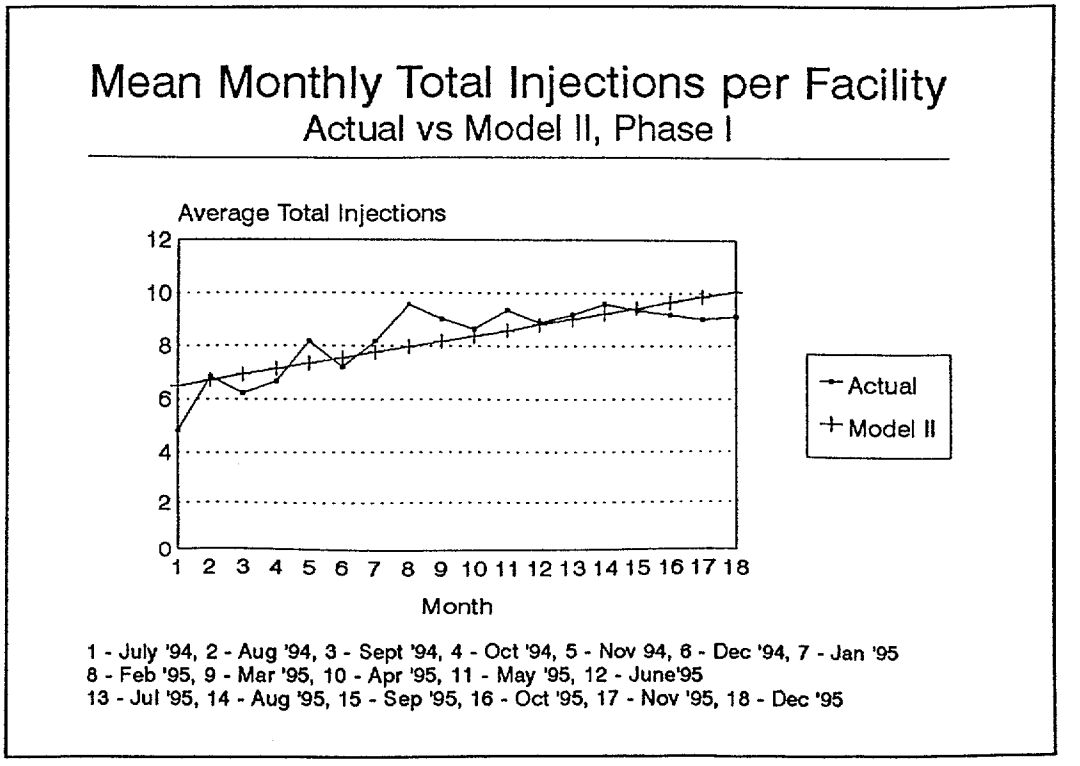


Figure 31

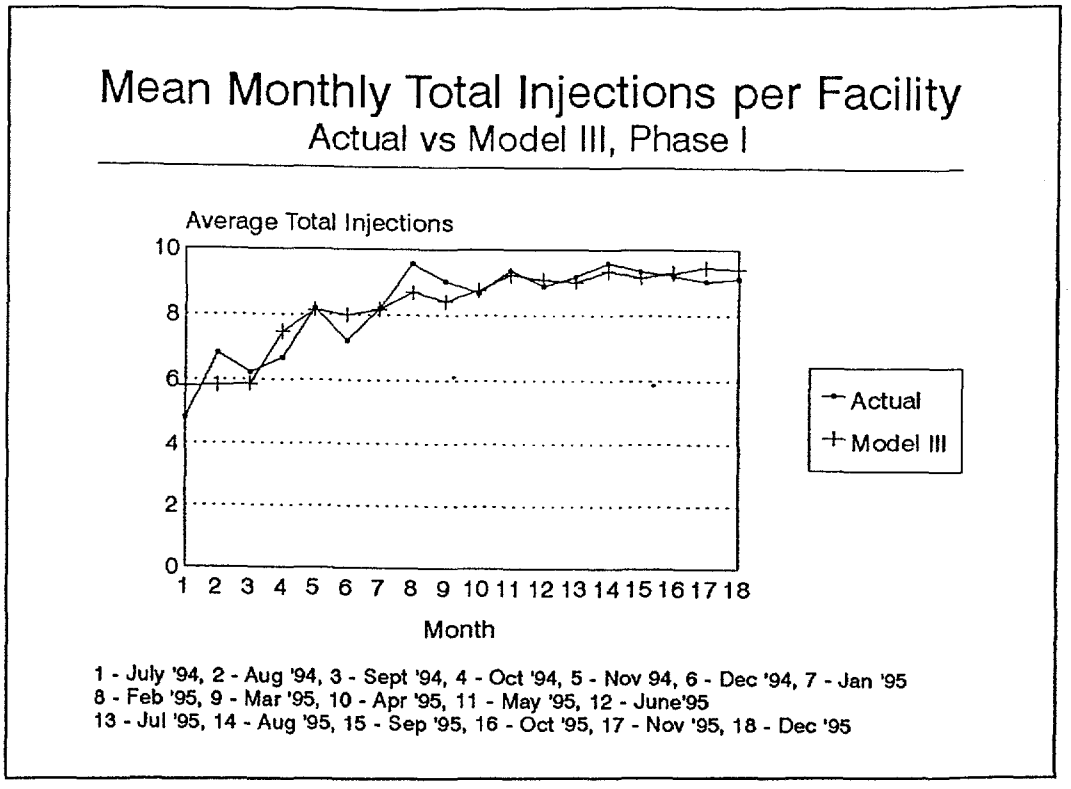


Figure 32

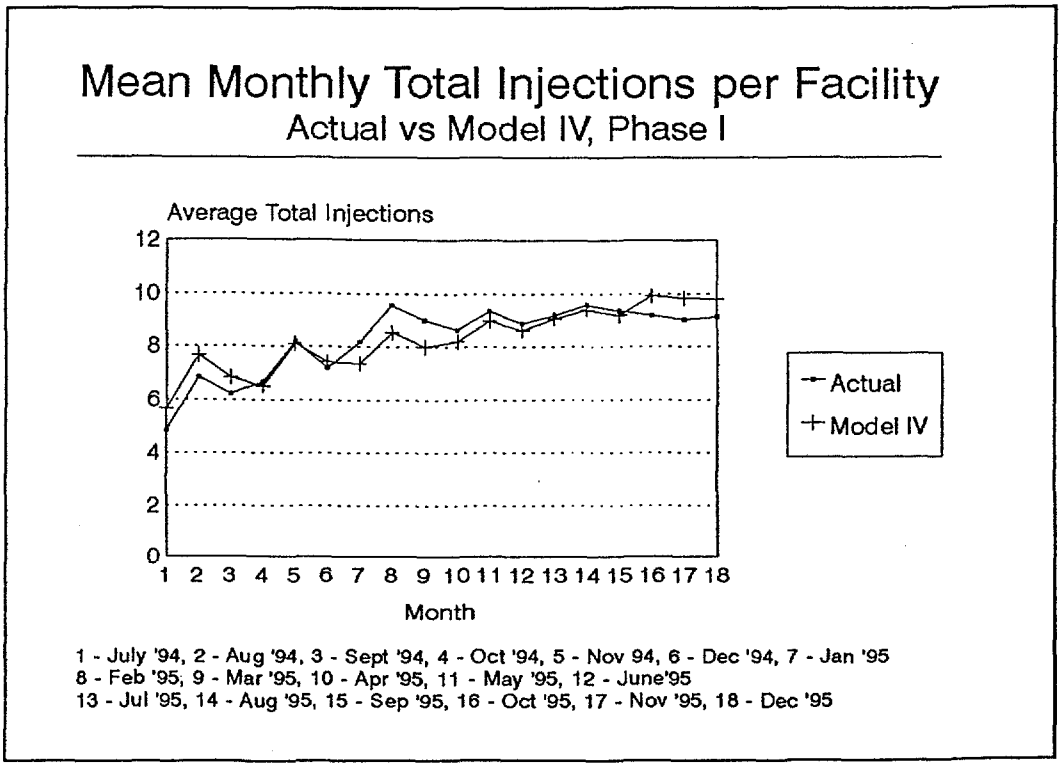


Figure 33

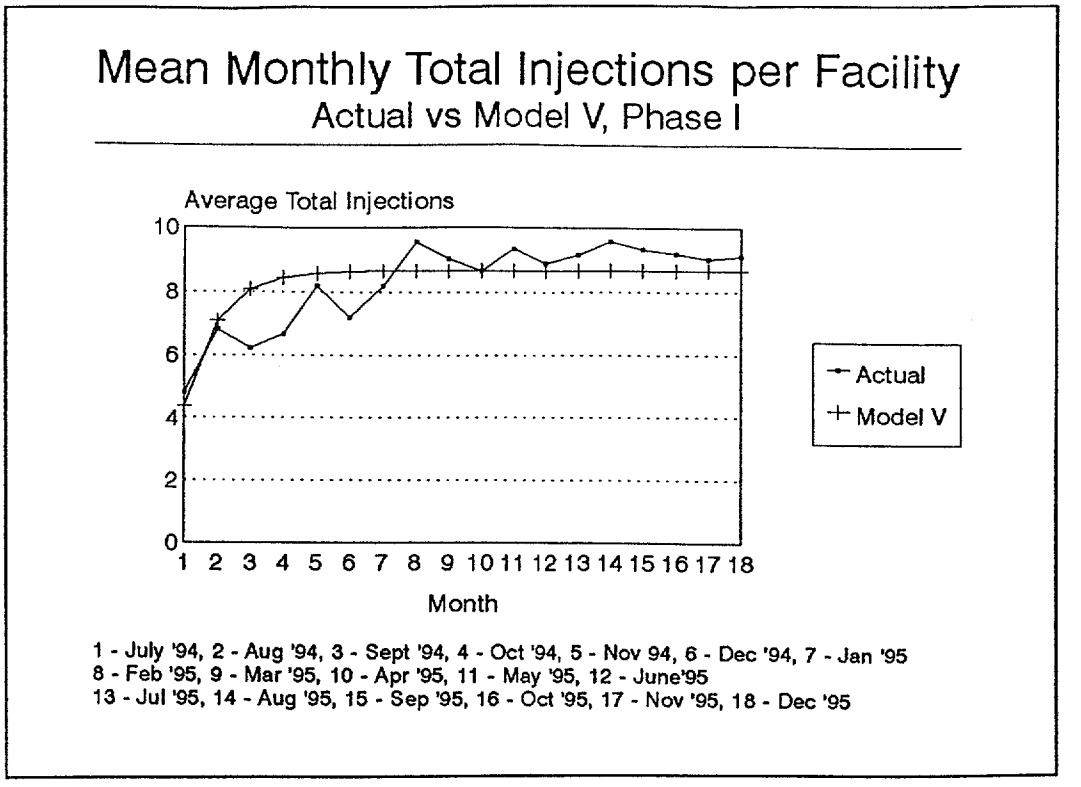


Figure 34

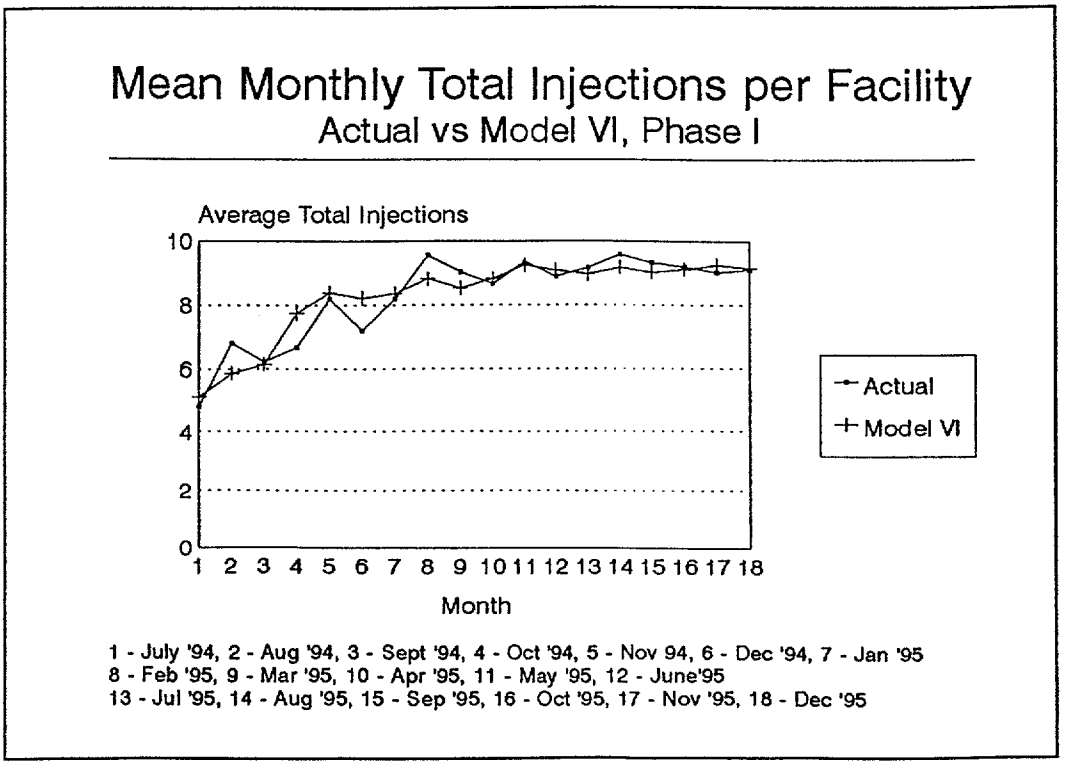
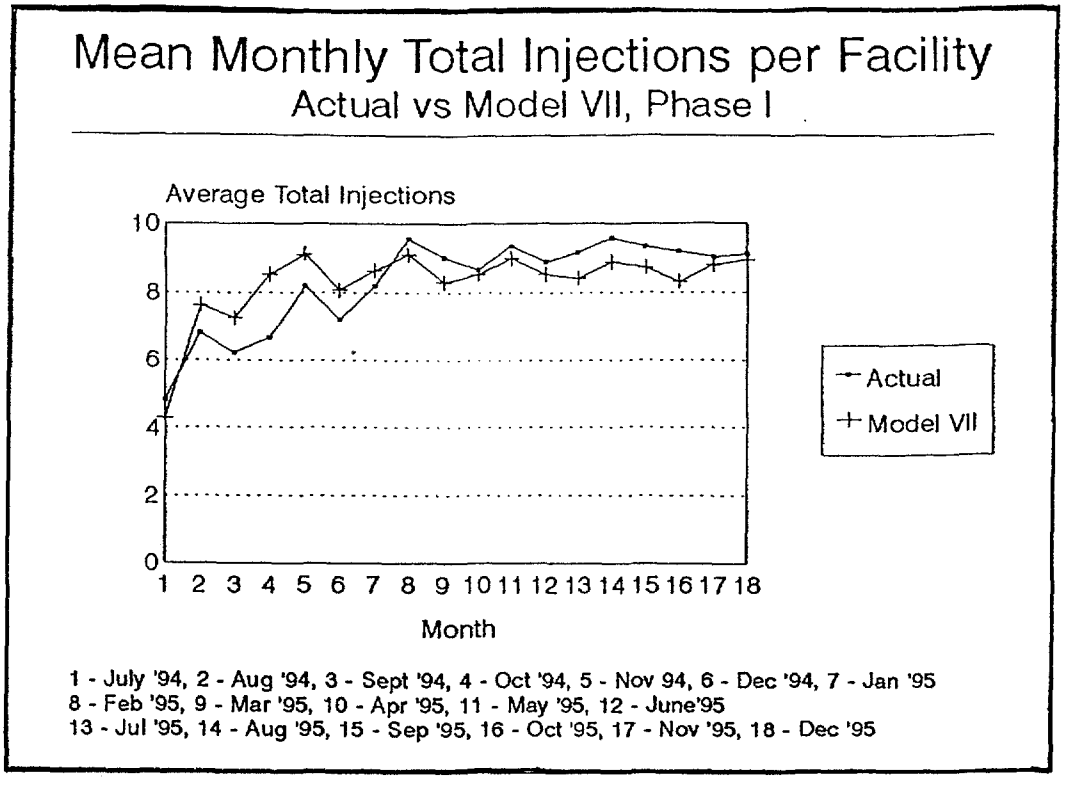


Figure 35



Applying the criteria in selecting the most appropriate model to use in formally recommending the demand for DMPA from 1995 to 1998 for the three phases of the DMPA Reintroduction Program, Model VI: Learning Curve Cum Lagged Model came out to be the most appropriate. Its two independent variables were both highly significant and accounted for 85.91 per cent of the variation in Y.

In the forecasts of average DMPA monthly total injections, Models II-IV had very optimistic forecasts going up from 9.4 in December 1995 to 15.2 in December 1997, which is a level much higher than that ever achieved during the observation period. Those of Models V-VII avoided this problem except that Model V exhibited a relatively low level of average monthly injections and Model VII showed very wide fluctuations in average monthly total injections. Model I, on the other hand, is too simplistic.

With Model VI as the basis, the total DMPA demand was estimated by multiplying the forecasted average monthly DMPA total injections by the total number of health facilities participating in the program. For 1995 the DMPA requirements was estimated to be 615,021 vials; for 1996, 1,091,104 vials; for 1997, 1,112,618 vials; and for 1998, 1,112,799 vials or a grand total of 3,316,521 vials (See Table 5). The number of facilities is expected to expand from 1,379 in Phase I to 4,097 in Phase II and 4,712 in Phase III.

Table 5. Projected DMPA Demand 1995-1998
Based on Targetted No. of Facilities

Year	No. of Facilities	DMPA Demand				Total
		1995	1996	1997	1998	
Phase I	1,379	146,730	151,099	150,629	150,625	599,083
Phase II	4,097	387,487	446,960	447,501	447,506	1,729,454
Phase III	4,712	80,804	493,045	514,488	514,579	1,603,016
Total	10,188	615,021	1,091,104	1,112,618	1,112,810	3,931,553

The Consumption Trend Report on DMPA as of May 23 1996 by the CDLMIS indicate a DMPA utilization of 355,945 vials in 1995. The current estimate of DMPA utilization for 1995 using Model VI totals 615,021 vials or 279,176 vials more.

This would have been easily reconciled, if the information on the number of facilities actually dispensing in Phase II and Phase III were available. Unfortunately, this was not the case. The CDLMIS Consumption Trend Report was based on returns from supply points and not from DMPA-dispensing facilities. Moreover, the reports on training of providers do not indicate the corresponding number of health facilities that they will be servicing.

To reconcile the projection figures and the Consumption Trend Report figures, the number of DMPA-dispensing facilities was derived by multiplying the number of trained DMPA providers in Phase II and Phase III by 0.7889, the ratio of the number of DMPA-dispensing facilities and number of DMPA-trained providers in Phase I. This could be interpreted to mean that for every 1000 DMPA-trained providers there will be 789 DMPA-dispensing facilitiies. Thus, the number of DMPA-dispensing facilities in Phase II and Phase III are 3,518 and 1,617 respectively (See Table 6).

Table 6. Number of DMPA-Trained Providers and Estimated Number of DMPA Facilities, Phase II and Phase III

Funding Agency	Phase II*	PhaseIII**
UNFPA USAID/EDF	2,600 1,829	1,098 951
Total	4,429	2,099
No. of Facilities***	3,518	1,617

* From FPS Table: DMPA Training Accomplishment - Phase II

** From Project Management Team, UNFPA Table: DMPA Training by Provinces (Oct-Dec 1995) and MSH Table: Number of Persons Trained in DMPA.

*** From Phase I data of 0.7889 DMPA-Dispensing Facility per DMPA-Trained Provider or 789 facilities per 1,000 trained provider.

The revised projection of DMPA demand using the estimated actual number of DMPA-dispensing facilities are 474,077 vials in 1995; 697,821 in 1996; 711,443 in 1997 and 711,509 in 1998 (See Table 7).

Inasmuch as the training of DMPA providers is not yet over and therefore the number of DMPA-dispensing facilities can increase during the year, the actual DMPA utilization for this year and succeeding years would range as follows:

1996	697,821 - 1,091,104 vials
1997	711,443 - 1,112,618 vials
1998	711,509 - 1,112,810 vials

Table 7. Projected DMPA Demand 1995-1998 Based on Estimated Number of DMPA-Dispensing Facilities

Year	No. of Facilities	DMPA Demand				Total
		1995	1996	1997	1998	
Phase I	1,379	146,730	151,099	150,629	150,625	599,083
Phase II	3,518	305,741	383,794	384,259	384,263	1,458,057
Phase III	1,617	21,606	162,928	176,555	176,621	537,710
Total	6,514	474,077	697,821	711,443	711,509	2,594,850

Figure 36

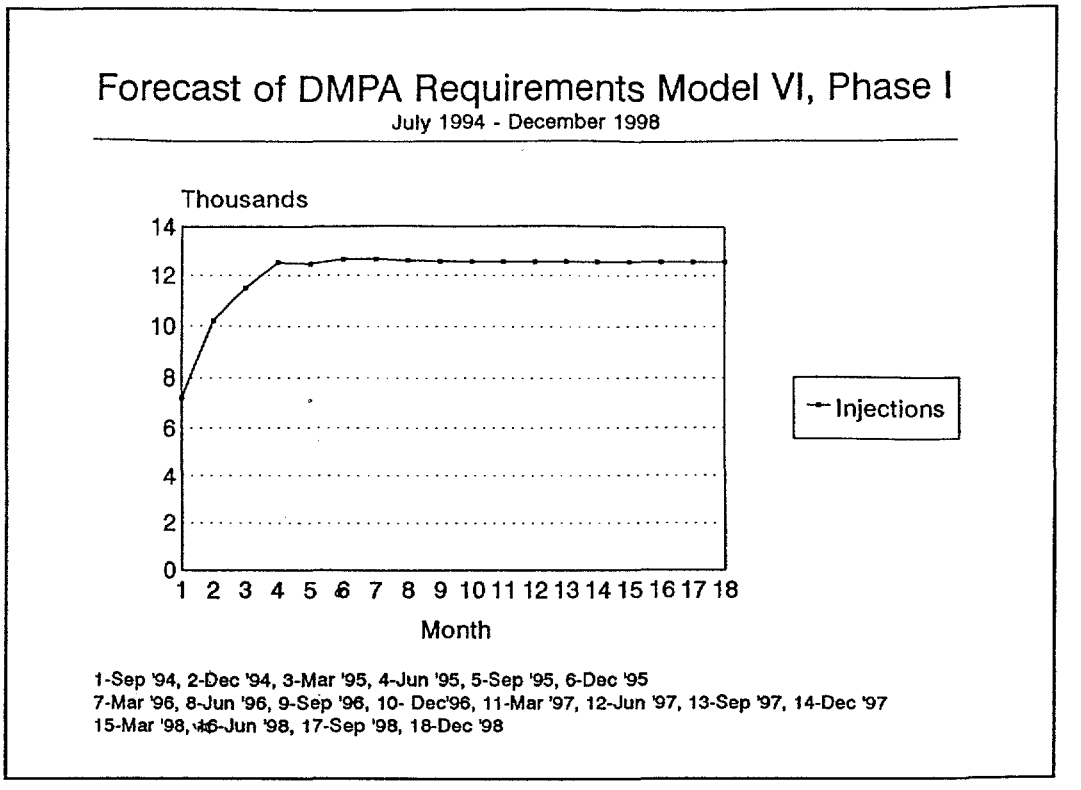


Figure 37

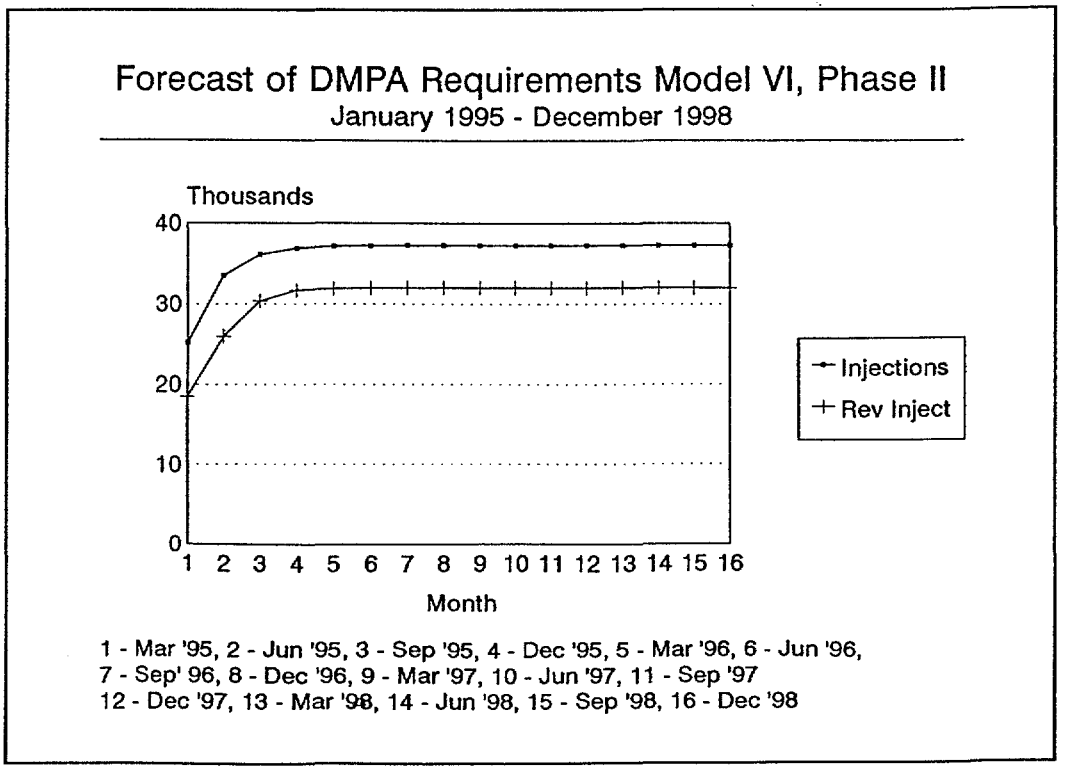
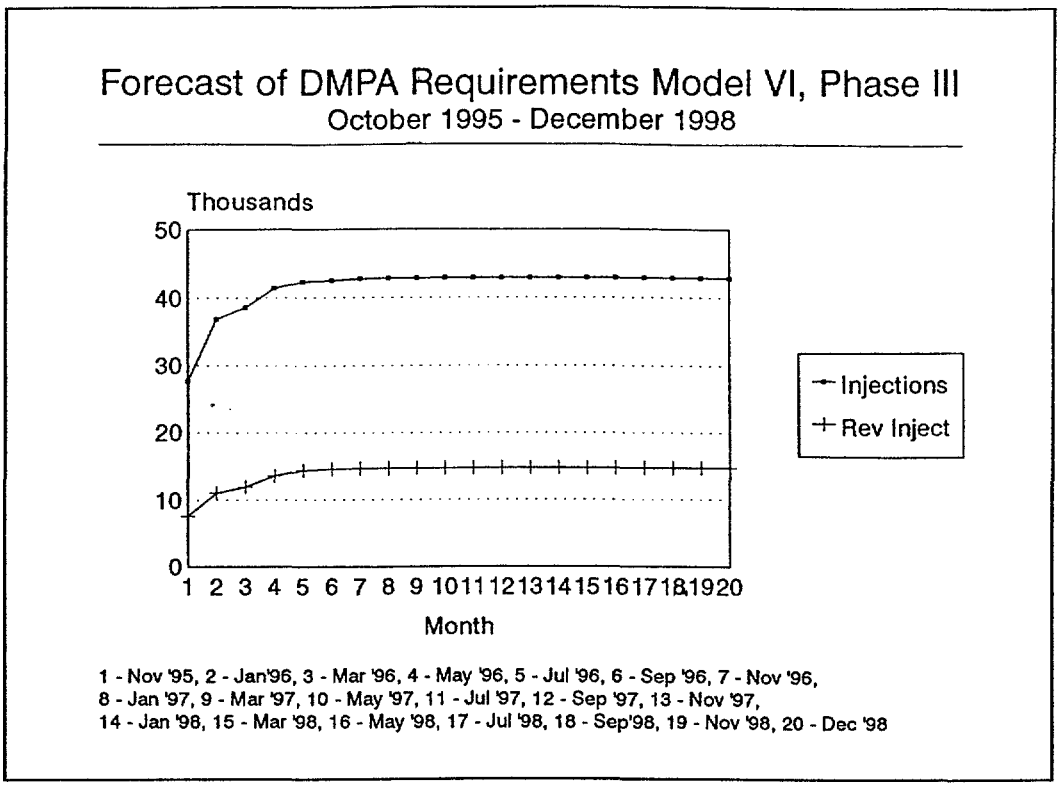


Figure 37


Forecast of DMPA Requirements Model VI, Phase III
October 1995 - December 1998
Thousands
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Month
Injections
Rev Inject
1 - Nov '95, 2 - Jan'96, 3 - Mar '96, 4 - May '96, 5 - Jul '96, 6 - Sep '96, 7 - Nov '96,
8 - Jan '97, 9 - Mar '97, 10 - May '97, 11 - Jul '97, 12 - Sep '97, 13 - Nov '97,
14 - Jan '98, 15 - Mar '98, 16 - May '98, 17 - Jul '98, 18 - Sep'98, 19 - Nov '98, 20 - Dec '98

SUMMARY AND POLICY IMPLICATIONS

Beginning in 1994 the injectable contraceptive Depo-medroxy Progesterone Acetate (DMPA) became available on a pilot basis in ten Local Government Units (LGUs) throughout the Philippines. These included Baguio City, Quezon City, Laguna, Pangasinan, Iloilo City, Cebu, Davao City, Davao del Sur, South Cotabato and Surigao del Sur. During this period the Population Council, in collaboration with the Department of Health, conducted an operations research study which collected monitoring data on program implementation and impact in the ten participating LGUs. Data were collected at this time on both the adoption of DMPA (first injections) and continuing use (reinjections) of this family planning method, as well as on the availability of DMPA supplies and IEC materials. The period of observation extended from April 1, 1994 to December 31, 1995.

A total of 157,662 DMPA injections were reported to have been dispensed in the ten pilot LGUs within the 21-month observation period. About forty percent (39.8 %) were given as first injections to new DMPA acceptors while 61.2 percent were given as reinjections. During the first three quarters, the total number of injections given out increased rapidly (from about 19,000 to 35,000 injections per quarter). Since then the number of reported injections stabilized at approximately 37,000 to 38,000 injections for every three-month period of observation.

First injections declined consistently during the 21-month period covered by the survey. The reported number of reinjections increased steadily up to the sixth quarterly round of data collection, thereafter declining slightly.

Altogether, the pilot LGUs averaged about 3 or 4 injections per facility per month during the first quarter. This increased to about 6 or 7 during the second quarter and then to 7 or 8 injections during the third quarter. During the last twelve months of the period

covered by this report, approximately nine DMPA injections were being disposed per reporting facility each month. For the whole 21-month observation period, the program dispensed an average of 7.5 injections per reporting facility per month.

The different LGUs varied considerably with regard to their performance in this regard. For the last year of observation, Quezon City and Baguio City were consistently dispensing an average of more than 15 injections per reporting facility per month. Pangasinan, Laguna and ,in particular, Iloilo City were all faring much more poorly, with the Iloilo City average typically coming to only about three injections per month.

As a whole, the sample cities averaged 11.6 injections per reporting facility per month while the provinces averaged 7.6 injections per reporting facility per month.

The overall reinjection rate was estimated at 71.3 percent. Of the 130,620 reinjections expected to be given between October 1994 to December 1995, a total of only 93,123 were actually dispensed.

Of the 62,736 DMPA acceptors in the ten pilot LGUs, only 25,175 were still using DMPA as of December 31, 1995. The overall proportion of current users as of the end of the study period was therefore about 40 percent.

Of the estimated 1.9 million MWRA in the ten pilot LGUs, 3.3 percent had accepted DMPA during the observation period while 1.4 percent of these acceptors were still using the method as of December 31, 1995.

Data were also collected on affiliated DMPA supplies. By the end of the observation period an average of 37 vials and syringes per facility were on stock for the overall sample. This statistic was again found to vary considerably among the different LGUs, being highest for Quezon City, Cebu and Baguio City and lowest in three of the Mindanao Provinces (South Cotabato, Davao Sur, Surigao Sur) as well as in Pangasinan.

A little less than a third of the pilot facilities had run out of reminder cards as of the end of the observation period. A similar proportion had no DMPA leaflets as of that same date. LGUs faring most poorly in this regard included Surigao Sur and South Cotabato (for both reminder cards and leaflets), Cebu (for reminder cards only) and Baguio City and Iloilo City (for leaflets only).

The reported decrease in the number of first injections and reinjections during the last six months of the observation period has been affected by the decline in the reporting rates of most of the LGUs. Estimates of the number of first injections and reinjections were made using a pro-rating procedure. These showed that a long-term trend towards a declining number of first injections has been underway in the study area for approximately the last four quarters under observation. Declines were highest in Pangasinan and South Cotabato. Declines were least in Davao City, Davao Sur and Surigao Sur, all of which represent LGUs from Mindanao.

Data from the study were used to project the total (nationwide) demand for DMPA over the period July 1995 to December 1998. Seven different mathematical models were compared for this purpose with the one which was best able to predict actual time trends during the data collection period (July 1994- December 1995) being eventually selected. This turned out to be a "Learning Curve Cum Lagged Model" which is based upon two major assumptions: first, that DMPA adoption will follow a "learning curve" pattern (increasing rapidly at first and then plateauing to a certain level after some time) and, second, that the total number of injections given three months earlier can serve as an additional predictor variable (since reinjections are due after a time lag of three months). The overall fit between this model and the pro-rated injection estimates was quite good ($R^2 = 0.86$).

The subsequent projection procedure was made somewhat difficult by reason of the fact that the DOH has not collected any information on the total number of health facilities in the country which have become equipped to dispense DMPA. Two different estimates

of the number of such facilities were obtained. Together these yielded a range for DMPA demand which may be projected for the next three years. These were approximately 700,000 to 1,100,000 vials of DMPA for each of the three years being considered (1996 to 1998) for an overall total of 2,100,000 to 3,200,000 vials.

Policy Implications:

Some of the major implications of the study for the current DMPA reintroduction program are listed below:

1. Data from this study have already been used to project future DMPA demand in the ten LGUs originally participating in the reintroduction effort. As the program's coverage is extended in an ever widening circle (with all LGUs set to participate by early 1996), future demand for DMPA can now be estimated for the nation as a whole using data from the study.

2. With an average of 37,000 injections per quarter, it may be estimated that DMPA was being used by about two percent of all married women of reproductive age in the ten LGUs under observation. As such, the method appears to be exerting a moderately positive impact upon overall levels of contraceptive use.

3. The considerable inter-LGU variation found for the number of DMPA users per facility indicates that programmatic factors may be involved here. For example, medical/legal barriers to DMPA use seem to have brought about the low acceptance rates found for Iloilo City whereas a lack of high-level political support was probably affecting the reintroduction campaign in Laguna. Continued monitoring of the different LGUs and follow-up of those with particularly low user rates are suggested.

4. An adequate supply of DMPA vials and syringes was found in most of the participating health centers. A similar conclusion could not be reached, however, for the case of DMPA reminder cards and leaflets. Mechanisms for ordering additional copies of these materials should be set in place and implemented thoroughly.

5. There is some evidence that the present logistical system is operating more efficiently in the case of LGUs located near the core region of Metro Manila. Additional efforts may be needed to reach health centers found in peripheral regions, e.g. Southern Mindanao.

6. Only about 3.3 percent of the MWRA have ever accepted DMPA. A more vigorous campaign to inform women about the availability of this method seems called for, especially in light of the trend towards a declining number of new DMPA acceptors which has been noted during the last twelve months of the study.

References

Patron, Maria Carmela and Marilou Palabrica-Costello. 1995. Experience with the DMPA Injectable Contraceptive: Findings from a Survey of DMPA Acceptors, Manila: Family Planning Operations Research and Training Program, Population Council.

Population Council, Manila. 1995. DMPA Monitoring Study: Findings on Use and Continuation Rates. Manila: Family Planning Operations Research and Training Program, Population Council.

Appendix A

1. Model I: Simple Arithmetic Expansion Model

This model is expressed as follows:

$$Y_i = Y_i'$$

where:

Y_i = Average Monthly Total Injections

Y_i' = Weighted Average of Monthly Total Injections

= 8.30

2. Model II: Simple Time Series Model

This Model is as follows:

$$Y_i = a + bX_i + e_i$$

where:

Y_i = Average Monthly Total Injections
X_i = Month:1, Jul '94;2, Aug, '94;..;18, Dec '95
e_i = error

3. Model III: Lagged Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + e_i$$

where:

Y_i = Average Monthly Total Injections
X_{1i} = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

X_{2i} = Average Monthly Total Injections 3 Months Earlier

4. Model IV: Sinusoidal Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + b_5X_{5i} + e_i$$

where:

Y_i = Average Monthly Total Injections

X_{1i} = t, Month: 1, Jul '94;2, Aug '94;..;18, Dec '95

X_{2i} = Cos $(2\pi t/3)$

X_{3i} = Sin $(2\pi t/3)$

X_{4i} = t Cos $(2\pi t/3)$

X_{5i} = t Sin $(2\pi t/3)$

5. Model V: Learning Curve Model

$$Y_i = a + b(1 - 1/e^t) + \text{error}$$

where:

Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

6. Model VI: Learning Curve Cum Lagged Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + e_i$$

where:

Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

$X_{1i} = (1 - 1/e^t)$

X_{2i} = Average Total Injections 3 Months Earlier

7. Model VII: Learning Curve Cum Sinusoidal Model

$$Y_i = a + b_1X_{1i} + b_2X_{2i} + b_3X_{3i} + b_4X_{4i} + b_5X_{5i} + e_i$$

where:

Y_i = Average Monthly Total Injections

e = Mathematical Constant Equal to 2.71928

t = Month:1, Jul '94;2, Aug '94;..;18, Dec '95

$X_{1i} = (1 - 1/e^t)$

$X_{2i} = \text{Cos}\ (2\pi t/3)$

$X_{3i} = \text{Sin}\ (2\pi t/3)$

$X_{4i} = t\ \text{Cos}\ (2\pi t/3)$

$X_{5i} = t\ \text{Sin}\ (2\pi t/3)$

APPENDIX B

DETAILS OF THE FORECASTING MODELS

MODEL I :	SIMPLE ARITHMETIC EXPANSION
MODEL II :	SIMPLE TIME SERIES MDOEL
MODEL III :	LAGGED MODEL
MODEL IV :	SINUSOIDAL MODEL
MODEL V :	LEARNING CURVE MODEL
MODEL VI :	LEARNING CURVE CUM LAGGED MODEL
MODEL VII :	LEARNING CURVE CUM SINUSOIDAL MODEL

MODEL I: SIMPLE ARITHMETIC EXPANSION

Average Total Injections Per Facility per Month	8.30
Total Number of Facilities	1,379
Total No. of Injections per Month	11,446

MONTH	t	ACTUAL	WEIGHTED MEAN	ERROR	(ERROR)^2	
JUL 94	1	4.83	8.30	3.47000	12.04090	
AUG 94	2	6.82	8.30	1.48000	2.19040	
SEP 94	3	6.23	8.30	2.07000	4.28490	
OCT 94	4	6.67	8.30	1.63000	2.65690	
NOV 94	5	8.18	8.30	0.12000	0.01440	
DEC 95	6	7.21	8.30	1.09000	1.18810	
JAN 95	7	8.19	8.30	0.11000	0.01210	
FEB 95	8	9.57	8.30	(1.27000)	1.61290	
MAR 95	9	9.03	8.30	(0.73000)	0.53290	
APR 95	10	8.65	8.30	(0.35000)	0.12250	
MAY 95	11	9.35	8.30	(1.05000)	1.10250	
JUN 95	12	8.89	8.30	(0.59000)	0.34810	
JUL 95	13	9.17	8.30	(0.87000)	0.75690	
AUG 95	14	9.58	8.30	(1.28000)	1.63840	
SEP 95	15	9.34	8.30	(1.04000)	1.08160	
OCT 95	16	9.19	8.30	(0.89000)	0.79210	
NOV 95	17	9.02	8.30	(0.72000)	0.51840	
DEC 95	18	9.12	8.30	(0.82000)	0.67240	
TOTAL		149.04	149.40	0.36	31.57	
		8.28	8.30	0.02000	1.85685	VARIANCE
					1.36266	STD DEV

FORECASTS: PHASE I
NO. OF FACILITIES: 1,379

MONTH	X	EST(Y)	INJECTIONS
JAN 96	19	8.30	11,446
FEB 96	20	8.30	11,446
MAR 96	21	8.30	11,446
APR 96	22	8.30	11,446
MAY 96	23	8.30	11,446
JUN 96	24	8.30	11,446
JUL 96	25	8.30	11,446
AUG 96	26	8.30	11,446
SEP 96	27	8.30	11,446
OCT 96	28	8.30	11,446
NOV 96	29	8.30	11,446
DEC 96	30	8.30	11,446
JAN 97	31	8.30	11,446
FEB 97	32	8.30	11,446
MAR 97	33	8.30	11,446
APR 97	34	8.30	11,446
MAY 97	35	8.30	11,446
JUN 97	36	8.30	11,446
JUL 97	37	8.30	11,446
AUG 97	38	8.30	11,446
SEP 97	39	8.30	11,446
OCT 97	40	8.30	11,446
NOV 97	41	8.30	11,446
DEC 97	42	8.30	11,446
JAN 96 - DEC 96			137,348
JAN 97 - DEC 97			137,348
JAN 78 - DEC 98			137,348
TOTAL			412,045

MODEL II: SIMPLE TIME SERIES MODEL

MONTH	Y	X	EST(Y)	ERROR	(ERROR)^2
JUL 94	4.83	1	6.50316	1.67316	2.79946
AUG 94	6.82	2	6.71220	(0.10780)	0.01162
SEP 94	6.23	3	6.92124	0.69124	0.47781
OCT 94	6.67	4	7.13028	0.46028	0.21186
NOV 94	8.18	5	7.33932	(0.84068)	0.70674
DEC 94	7.21	6	7.54836	0.33836	0.11449
JAN 95	8.19	7	7.75740	(0.43260)	0.18714
FEB 95	9.57	8	7.96644	(1.60356)	2.57141
MAR 95	9.03	9	8.17548	(0.85452)	0.73020
APR 95	8.65	10	8.38452	(0.26548)	0.07048
MAY 95	9.35	11	8.59356	(0.75644)	0.57220
JUN 95	8.89	12	8.80260	(0.08740)	0.00764
JUL 95	9.17	13	9.01164	(0.15836)	0.02508
AUG 95	9.58	14	9.22068	(0.35932)	0.12911
SEP 95	9.34	15	9.42972	0.08972	0.00805
OCT 95	9.19	16	9.63876	0.44876	0.20139
NOV 95	9.02	17	9.84780	0.82780	0.68526
DEC 95	9.12	18	10.05684	0.93684	0.87767
TOTAL	149.04	171	149.04000	(0.00000)	10.38760
MEAN	8.28	10	9.93600	(0.00000)	0.64923 VARIANCE
					0.80575 STD DEV

MODEL II: SIMPLE TIME SERIES MODEL

Y = a + bX + e

Y = Average Total Injections for the month
X = Month: 1,July 94; 2,Aug 94;...; 18,Dec 95

MONTH	Y	X	YY	YX	XX
JUL 94	4.83	1	23.3289	4.83	1
AUG 94	6.82	2	46.5124	13.64	4
SEP 94	6.23	3	38.8129	18.69	9
OCT 94	6.67	4	44.4889	26.68	16
NOV 94	8.18	5	66.9124	40.90	25
DEC 94	7.21	6	51.9841	43.26	36
JAN 95	8.19	7	67.0761	57.33	49
FEB 95	9.57	8	91.5849	76.56	64
MAR 95	9.03	9	81.5409	81.27	81
APR 95	8.65	10	74.8225	86.50	100
MAY 95	9.35	11	87.4225	102.85	121
JUN 95	8.89	12	79.0321	106.68	144
JUL 95	9.17	13	84.0889	119.21	169
AUG 95	9.58	14	91.7764	134.12	196
SEP 95	9.34	15	87.2356	140.10	225
OCT 95	9.19	16	84.4561	147.04	256
NOV 95	9.02	17	81.3604	153.34	289
DEC 95	9.12	18	83.1744	164.16	324
TOTAL	149.04	171.00	1,265.61	1,517.16	2,109.00
MEAN	8.28	10			

Syy = 31.55920 Sxy = 101.28000 Sxx = 484.50000

b = 0.20904 a = 6.29412

SSTotal = 31.55920 SSRegn = 21.17160

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	1	21.17160	21.17160	32.61056 **
ERROR	16	10.38760	0.64923	
TOTAL	17	31.55920		

RR 67.08534

REGN COEF a b

6.29412 0.20904

FORECASTS: PHASE I

NO. OF FACILITIES: 1,379

MONTH	X1	EST(Y)	INJECTIONS
JAN 96	19.00	10.26588	14,157
FEB 96	20.00	10.47492	14,445
MAR 96	21.00	10.68396	14,733
APR 96	22.00	10.89300	15,021
MAY 96	23.00	11.10204	15,310
JUN 96	24.00	11.31108	15,598
JUL 96	25.00	11.52012	15,886
AUG 96	26.00	11.72916	16,175
SEP 96	27.00	11.93820	16,463
OCT 96	28.00	12.14724	16,751
NOV 96	29.00	12.35628	17,039
DEC 96	30.00	12.56533	17,328
JAN 97	31.00	12.77437	17,616
FEB 97	32.00	12.98341	17,904
MAR 97	33.00	13.19245	18,192
APR 97	34.00	13.40149	18,481
MAY 97	35.00	13.61053	18,769
JUN 97	36.00	13.81957	19,057
JUL 97	37.00	14.02861	19,345
AUG 97	38.00	14.23765	19,634
SEP 97	39.00	14.44669	19,922
OCT 97	40.00	14.65573	20,210
NOV 97	41.00	14.86477	20,499
DEC 97	42.00	15.07381	20,787

JAN 96 - DEC 96	188,905
JAN 97 - DEC 97	230,416
TOTAL	419,321

MODEL III: LAGGED MODEL

$Y = a + b1X1 + b2X2 + e$

Y = Average Total Injections for the month
X1 = Month: 1,July 94; 2,Aug 94;...; 18,Dec 95
X2 = Average Total Injections 3 months earlier

MONTH	Y	X1	X2	YY	YX1	YX2	X1X1	X1X2	X2X2
JUL 94	4.83	1	0.00	23.3289	4.83	0.0000	1	0.00	0.0000
AUG 94	6.82	2	0.00	46.5124	13.64	0.0000	4	0.00	0.0000
SEP 94	6.23	3	0.00	38.8129	18.69	0.0000	9	0.00	0.0000
OCT 94	6.67	4	4.83	44.4889	26.68	32.2161	16	19.32	23.3289
NOV 94	8.18	5	6.82	66.9124	40.90	55.7876	25	34.10	46.5124
DEC 94	7.21	6	6.23	51.9841	43.26	44.9183	36	37.38	38.8129
JAN 95	8.19	7	6.67	67.0761	57.33	54.6273	49	46.69	44.4889
FEB 95	9.57	8	8.18	91.5849	76.56	78.2826	64	65.44	66.9124
MAR 95	9.03	9	7.21	81.5409	81.27	65.1063	81	64.89	51.9841
APR 95	8.65	10	8.19	74.8225	86.50	70.8435	100	81.90	67.0761
MAY 95	9.35	11	9.57	87.4225	102.85	89.4795	121	105.27	91.5849
JUN 95	8.89	12	9.03	79.0321	106.68	80.2767	144	108.36	81.5409
JUL 95	9.17	13	8.65	84.0889	119.21	79.3205	169	112.45	74.8225
AUG 95	9.58	14	9.55	91.7764	134.12	91.4890	196	133.70	91.2025
SEP 95	9.34	15	8.89	87.2356	140.10	83.0326	225	133.35	79.0321
OCT 95	9.19	16	9.17	84.4561	147.04	84.2723	256	146.72	84.0889
NOV 95	9.02	17	9.58	81.3604	153.34	86.4116	289	162.86	91.7764
DEC 95	9.12	18	9.34	83.1744	164.16	85.1808	324	168.12	87.2356
TOTAL	149.04	171	121.91	1,265.6104	1,517.16	1,081.2447	2,109	1,420.55	1,020.3995
MEAN	8.28	10	6.77						

	X1	X2	Y	b	bSxy	SSR	SST	SSE	RR
X1	484.50000	262.40500	101.28000	0.03428	3.47162				
X2		194.73016	71.82990	0.32268	23.17800	26.64962	31.55920	4.90958	84.44
A1	484.50000	262.40500	101.28000						
B1	1.00000	0.54160	0.20904	0.03428	21.17160				
A2		52.61172	16.97669						
B2		1.00000	0.32268	0.32268	5.47802	26.64962	31.55920	4.90958	84.44
a =	5.76893								

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION				
X1-X2	2	26.64962	13.32481	40.71062 **
X1	1	21.17160	21.17160	64.68451 **
X2	1	5.47802	5.47802	16.73672 NS
ERROR	15	4.90958	0.32731	
TOTAL	17	31.55920		

RR	84.44
RR X1	67.09

MODEL III: LAGGED MODEL

MONTH	Y1	X1	X2	EST(Y)	ERROR	(ERROR)^2
JUL 94	4.83	1.00	0.00	5.80321	0.97321	0.94714
AUG 94	6.82	2.00	0.00	5.83749	(0.98251)	0.96533
SEP 94	6.23	3.00	0.00	5.87176	(0.35824)	0.12833
OCT 94	6.67	4.00	4.83	7.46458	0.79458	0.63136
NOV 94	8.18	5.00	6.82	8.14099	(0.03901)	0.00152
DEC 94	7.21	6.00	6.23	7.98489	0.77489	0.60045
JAN 95	8.19	7.00	6.67	8.16114	(0.02886)	0.00083
FEB 95	9.57	8.00	8.18	8.68266	(0.88734)	0.78736
MAR 95	9.03	9.00	7.21	8.40394	(0.62606)	0.39195
APR 95	8.65	10.00	8.19	8.75445	0.10445	0.01091
MAY 95	9.35	11.00	9.57	9.23402	(0.11598)	0.01345
JUN 95	8.89	12.00	9.03	9.09405	0.20405	0.04164
JUL 95	9.17	13.00	8.65	9.00571	(0.16429)	0.02699
AUG 95	9.58	14.00	9.55	9.33040	(0.24960)	0.06230
SEP 95	9.34	15.00	8.89	9.15171	(0.18829)	0.03545
OCT 95	9.19	16.00	9.17	9.27634	0.08634	0.00745
NOV 95	9.02	17.00	9.58	9.44291	0.42291	0.17885
DEC 95	9.12	18.00	9.34	9.39975	0.27975	0.07826
TOTAL	149.04	171.00	121.91	149.04000	(0.00000)	4.90958
MEAN	8.28	9.50	6.77	8.28000	(0.00000)	0.32731 VARIANCE
						0.57211 STD DEV

REGN COEF	a	b1	b2
	5.76893	0.03428	0.32268

FORECASTS: PHASE I

NO. OF FACILITIES: 1,379

MONTH	X1	X2	EST(Y)	INJECTIONS
JAN 96	19.00	9.19	9.38562	12,943
FEB 96	20.00	9.02	9.36504	12,914
MAR 96	21.00	9.12	9.43159	13,006
APR 96	22.00	9.39	9.55158	13,172
MAY 96	23.00	9.37	9.57922	13,210
JUN 96	24.00	9.43	9.63497	13,287
JUL 96	25.00	9.55	9.70796	13,387
AUG 96	26.00	9.58	9.75116	13,447
SEP 96	27.00	9.63	9.80342	13,519
OCT 96	28.00	9.71	9.86126	13,599
NOV 96	29.00	9.75	9.90947	13,665
DEC 96	30.00	9.80	9.96061	13,736
JAN 97	31.00	9.86	10.01355	13,809
FEB 97	32.00	9.91	10.06339	13,877
MAR 97	33.00	9.96	10.11417	13,947
APR 97	34.00	10.01	10.16553	14,018
MAY 97	35.00	10.06	10.21589	14,088
JUN 97	36.00	10.11	10.26655	14,158
JUL 97	37.00	10.17	10.31740	14,228
AUG 97	38.00	10.22	10.36793	14,297
SEP 97	39.00	10.27	10.41855	14,367
OCT 97	40.00	10.32	10.46924	14,437
NOV 97	41.00	10.37	10.51982	14,507
DEC 97	42.00	10.42	10.57043	14,577

JAN 96 - DEC 96	159,884
JAN 97 - DEC 97	170,310
TOTAL	330,194

MODEL IV: SINUSOIDAL MODEL

$$Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + e$$

Y = Average Total Injections for the month
X1 = t, Month: 1,July 94; 2,Aug 94;...; 18,Dec 95
X2 = Cos (2 t/3)
X3 = Sin (2 t/3)
X4 = t Cos (2 t/3)
X5 = t Sin (2 t/3)

MONTH	Y	X1	X2	X3	X4	X5	YY	YX1	YX2	YX3	YX4	YX5	X1X1	X1X2
JUL 94	4.83	1	(0.50)	0.86602	(0.50)	0.86602	23.3289	4.83	(2.4150)	4.18288	(2.4150)	4.18288	1	(0.50)
AUG 94	6.82	2	(0.50)	(0.86602)	(1.00)	(1.73204)	46.5124	13.64	(3.4100)	(5.90625)	(6.8200)	(11.81251)	4	(1.00)
SEP 94	6.23	3	1.00	0.00000	3.00	0.00000	38.8129	18.69	6.2300	0.00000	18.6900	0.00000	9	3.00
OCT 94	6.67	4	(0.50)	0.86602	(2.00)	3.46408	44.4889	26.68	(3.3350)	5.77635	(13.3400)	23.10541	16	(2.00)
NOV 94	8.18	5	(0.50)	(0.86602)	(2.50)	(4.33010)	66.9124	40.90	(4.0900)	(7.08404)	(20.4500)	(35.42022)	25	(2.50)
DEC 94	7.21	6	1.00	0.00000	6.00	0.00000	51.9841	43.26	7.2100	0.00000	43.2600	0.00000	36	6.00
JAN 95	8.19	7	(0.50)	0.86602	(3.50)	6.06214	67.0761	57.33	(4.0950)	7.09270	(28.6650)	49.64893	49	(3.50)
FEB 95	9.57	8	(0.50)	(0.86602)	(4.00)	(6.92816)	91.5849	76.56	(4.7850)	(8.28781)	(38.2800)	(66.30249)	64	(4.00)
MAR 95	9.03	9	1.00	0.00000	9.00	0.00000	81.5409	81.27	9.0300	0.00000	81.2700	0.00000	81	9.00
APR 95	8.65	10	(0.50)	0.86602	(5.00)	8.66020	74.8225	86.50	(4.3250)	7.49107	(43.2500)	74.91073	100	(5.00)
MAY 95	9.35	11	(0.50)	(0.86602)	(5.50)	(9.52622)	87.4225	102.85	(4.6750)	(8.09729)	(51.4250)	(89.07016)	121	(5.50)
JUN 95	8.89	12	1.00	0.00000	12.00	0.00000	79.0321	106.68	8.8900	0.00000	106.6800	0.00000	144	12.00
JUL 95	9.17	13	(0.50)	0.86602	(6.50)	11.25826	84.0889	119.21	(4.5850)	7.94140	(59.6050)	103.23824	169	(6.50)
AUG 95	9.58	14	(0.50)	(0.86602)	(7.00)	(12.12428)	91.7764	134.12	(4.7900)	(8.29647)	(67.0600)	(116.15060)	196	(7.00)
SEP 95	9.34	15	1.00	0.00000	15.00	0.00000	87.2356	140.10	9.3400	0.00000	140.1000	0.00000	225	15.00
OCT 95	9.19	16	(0.50)	0.86602	(8.00)	13.85632	84.4561	147.04	(4.5950)	7.95872	(73.5200)	127.33958	256	(8.00)
NOV 95	9.02	17	(0.50)	(0.86602)	(8.50)	(14.72234)	81.3604	153.34	(4.5100)	(7.81150)	(76.6700)	(132.79551)	289	(8.50)
DEC 95	9.12	18	1.00	0.00000	18.00	0.00000	83.1744	164.16	9.1200	0.00000	164.1600	0.00000	324	18.00
TOTAL	149.04	171	0.00	0.00000	9.00	(5.19612)	1,265.6104	1,517.16	0.2100	(5.04024)	72.6600	(69.12572)	2,109	9.00
MEAN	8.28	10	0.00	0.00000	0.50	(0.28867)								

MONTH	X1X3	X1X4	X1X5	X2X2	X2X3	X2X4	X2X5	X3X3	X3X4	X3X5	X4X4	X4X5	X5X5
JUL 94	0.86602	(0.50)	0.86602	0.25	(0.43301)	0.25	(0.43301)	0.74999	(0.43301)	0.74999	0.25	(0.43301)	0.74999
AUG 94	(1.73204)	(2.00)	(3.46408)	0.25	0.43301	0.50	0.86602	0.74999	0.86602	1.49998	1.00	1.73204	2.99996
SEP 94	0.00000	9.00	0.00000	1.00	0.00000	3.00	0.00000	0.00000	0.00000	0.00000	9.00	0.00000	0.00000
OCT 94	3.46408	(8.00)	13.85632	0.25	(0.43301)	1.00	(1.73204)	0.74999	(1.73204)	2.99996	4.00	(6.92816)	11.99985
NOV 94	(4.33010)	(12.50)	(21.65050)	0.25	0.43301	1.25	2.16505	0.74999	2.16505	3.74995	6.25	10.82525	18.74977
DEC 94	0.00000	36.00	0.00000	1.00	0.00000	6.00	0.00000	0.00000	0.00000	0.00000	36.00	0.00000	0.00000
JAN 95	6.06214	(24.50)	42.43498	0.25	(0.43301)	1.75	(3.03107)	0.74999	(3.03107)	5.24993	12.25	(21.21749)	36.74954
FEB 95	(6.92816)	(32.00)	(55.42528)	0.25	0.43301	2.00	3.46408	0.74999	3.46408	5.99993	16.00	27.71264	47.99940
MAR 95	0.00000	81.00	0.00000	1.00	0.00000	9.00	0.00000	0.00000	0.00000	0.00000	81.00	0.00000	0.00000
APR 95	8.66020	(50.00)	86.60200	0.25	(0.43301)	2.50	(4.33010)	0.74999	(4.33010)	7.49991	25.00	(43.30100)	74.99906
MAY 95	(9.52622)	(60.50)	(104.78842)	0.25	0.43301	2.75	4.76311	0.74999	4.76311	8.24990	30.25	52.39421	90.74887
JUN 95	0.00000	144.00	0.00000	1.00	0.00000	12.00	0.00000	0.00000	0.00000	0.00000	144.00	0.00000	0.00000
JUL 95	11.25826	(84.50)	146.35738	0.25	(0.43301)	3.25	(5.62913)	0.74999	(5.62913)	9.74988	42.25	(73.17869)	126.74842
AUG 95	(12.12428)	(98.00)	(169.73992)	0.25	0.43301	3.50	6.06214	0.74999	6.06214	10.49987	49.00	84.86996	146.99817
SEP 95	0.00000	225.00	0.00000	1.00	0.00000	15.00	0.00000	0.00000	0.00000	0.00000	225.00	0.00000	0.00000
OCT 95	13.85632	(128.00)	221.70112	0.25	(0.43301)	4.00	(6.92816)	0.74999	(6.92816)	11.99985	64.00	(110.85056)	191.99760
NOV 95	(14.72234)	(144.50)	(250.27978)	0.25	0.43301	4.25	7.36117	0.74999	7.36117	12.74984	72.25	125.13989	216.74730
DEC 95	0.00000	324.00	0.00000	1.00	0.00000	18.00	0.00000	0.00000	0.00000	0.00000	324.00	0.00000	0.00000
TOTAL	(5.19612)	174.00	(93.53016)	9.00	0.00000	90.00	2.59806	8.99989	2.59806	30.99879	1,141.50	46.76508	967.48793

	X1	X2	X3	X4	X5	Y	b	bSxy	SSR	SST	SSE	
X1	494.50000	9.00000	(5.19612)	88.50000	(44.16702)	101.28000	0.20775	21.04052				
X2		9.00000	0.00000	90.00000	2.59806	0.21000	(0.10184)	(0.02139)				
X3			8.99999	2.59806	30.99399	(5.04024)	(1.16845)	5.88929				
X4				1,137.00000	49.36314	(1.86000)	(0.01060)	0.01972				
X5					965.98794	(26.10184)	0.08127	(2.12128)	24.80686	31.55920	6.75234	78.604
A1	494.50000	9.00000	(5.19612)	88.50000	(44.16702)	101.28000						
B1	1.00000	0.01858	(0.01072)	0.18266	(0.09116)	0.20904	0.20775	21.17160				
A2		8.83282	0.09652	88.35604	3.41850	(1.67136)						
B2		1.00000	0.01093	10.00315	0.38702	(0.18922)	(0.10184)	0.31626				
A3			8.94311	2.58167	80.48795	(3.73577)						
B3			1.00000	0.28868	9.00000	(0.44009)	(1.16845)	1.73210				
A4				236.25000	(0.00000)	(2.50500)						
B4				1.00000	(0.00000)	(0.01060)	(0.01060)	0.02656				
A5					236.24705	19.19966						
B5					1.00000	0.08127	0.08127	1.56035	24.80686	31.55920	6.75234	78.

a 6.33517

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION				
X1-X5	5	24.80686	4.96137	8.81716 **
X1	1	21.17160	21.17160	37.62533 **
X2	1	0.31626	0.31626	0.56204 NS
X3	1	1.73210	1.73210	3.07821 NS
X4	1	0.02656	0.02656	0.04720 NS
X5	1	1.56035	1.56035	2.77299 NS
X2-X5	4	3.63526	0.90882	1.61511 NS
ERROR	12	6.75234	0.56270	
TOTAL	17	31.55920		

RR 78.60
RR X1 67.09

75

MODEL IV: SINUSOIDAL MODEL

MONTH	Y	X1	X2	X3	X4	X5	EST(Y)	ERROR	(ERROR)^2	
JUL 94	4.83	1.00	(0.50000)	0.86602	(0.50000)	0.86602	5.65762	0.82762	0.68495	
AUG 94	6.82	2.00	(0.50000)	(0.86602)	(1.00000)	(1.73204)	7.68333	0.86333	0.74534	
SEP 94	6.23	3.00	1.00000	0.00000	3.00000	0.00000	6.82476	0.59476	0.35374	
OCT 94	6.67	4.00	(0.50000)	0.86602	(2.00000)	3.46408	6.50790	(0.16210)	0.02627	
NOV 94	8.18	5.00	(0.50000)	(0.86602)	(2.50000)	(4.33010)	8.11133	(0.06867)	0.00472	
DEC 94	7.21	6.00	1.00000	0.00000	6.00000	0.00000	7.41619	0.20619	0.04251	
JAN 95	8.19	7.00	(0.50000)	0.86602	(3.50000)	6.06214	7.35819	(0.83181)	0.69191	
FEB 95	9.57	8.00	(0.50000)	(0.86602)	(4.00000)	(6.92816)	8.53933	(1.03067)	1.06227	
MAR 95	9.03	9.00	1.00000	0.00000	9.00000	0.00000	8.00762	(1.02238)	1.04526	
APR 95	8.65	10.00	(0.50000)	0.86602	(5.00000)	8.66020	8.20848	(0.44152)	0.19494	
MAY 95	9.35	11.00	(0.50000)	(0.86602)	(5.50000)	(9.52622)	8.96733	(0.38267)	0.14643	
JUN 95	8.39	12.00	1.00000	0.00000	12.00000	0.00000	8.59905	(0.29095)	0.08465	
JUL 95	9.17	13.00	(0.50000)	0.86602	(6.50000)	11.25826	9.05876	(0.11124)	0.01237	
AUG 95	9.58	14.00	(0.50000)	(0.86602)	(7.00000)	(12.12428)	9.39533	(0.18467)	0.03410	
SEP 95	9.34	15.00	1.00000	0.00000	15.00000	0.00000	9.19048	(0.14952)	0.02236	
OCT 95	9.19	16.00	(0.50000)	0.86602	(8.00000)	13.85632	9.90905	0.71905	0.51703	
NOV 95	9.02	17.00	(0.50000)	(0.86602)	(8.50000)	(14.72234)	9.82333	0.80333	0.64534	
DEC 95	9.12	18.00	1.00000	0.00000	18.00000	0.00000	9.78190	0.66190	0.43812	
TOTAL	149.04	171.00	0.00000	0.00000	9.00000	(5.19612)	149.04000	(0.00000)	6.75234	
MEAN	8.28	9.50	0.00000	0.00000	0.50000	(0.28867)	12.42000	(0.00000)	0.56270	VARIANCE
									0.75013	STD DEV

REGRESSION COEFFICIENTS

a	b1	b2	b3	b4	b5
6.33517	0.20775	(0.10184)	(1.16845)	(0.01060)	0.08127

FORECASTS: PHASE I
NO. OF FACILITIES 1,379

MONTH	Y	X1	X2	X3	X4	X5	EST(Y)	INJECTIONS
JAN 96		19.00	(0.50000)	0.86602	(9.50000)	16.45438	10.75933	14,837
FEB 96		20.00	(0.50000)	(0.86602)	(10.00000)	(17.32040)	10.25133	14,137
MAR 96		21.00	1.00000	0.00000	21.00000	0.00000	10.37333	14,305
APR 96		22.00	(0.50000)	0.86602	(11.00000)	19.05244	11.60962	16,010
MAY 96		23.00	(0.50000)	(0.86602)	(11.50000)	(19.91846)	10.67933	14,727
JUN 96		24.00	1.00000	0.00000	24.00000	0.00000	10.96476	15,120
JUL 96		25.00	(0.50000)	0.86602	(12.50000)	21.65050	12.45990	17,182
AUG 96		26.00	(0.50000)	(0.86602)	(13.00000)	(22.51652)	11.10733	15,317
SEP 96		27.00	1.00000	0.00000	27.00000	0.00000	11.55619	15,936
OCT 96		28.00	(0.50000)	0.86602	(14.00000)	24.24856	13.31919	18,355
NOV 96		29.00	(0.50000)	(0.86602)	(14.50000)	(25.11458)	11.53533	15,907
DEC 96		30.00	1.00000	0.00000	30.00000	0.00000	12.14762	16,752
JAN 97		31.00	(0.50000)	0.86602	(15.50000)	26.84662	14.16048	19,527
FEB 97		32.00	(0.50000)	(0.86602)	(16.00000)	(27.71264)	11.96333	16,497
MAR 97		33.00	1.00000	0.00000	33.00000	0.00000	12.73905	17,567
APR 97		34.00	(0.50000)	0.86602	(17.00000)	29.44468	15.01076	20,700
MAY 97		35.00	(0.50000)	(0.86602)	(17.50000)	(30.31070)	12.39133	17,083
JUN 97		36.00	1.00000	0.00000	36.00000	0.00000	13.33048	18,383
JUL 97		37.00	(0.50000)	0.86602	(18.50000)	32.04274	15.86105	21,872
AUG 97		38.00	(0.50000)	(0.86602)	(19.00000)	(32.90876)	12.81933	17,678
SEP 97		39.00	1.00000	0.00000	39.00000	0.00000	13.92190	19,198
OCT 97		40.00	(0.50000)	0.86602	(20.00000)	34.64080	16.71133	23,045
NOV 97		41.00	(0.50000)	(0.86602)	(20.50000)	(35.50682)	13.24733	18,268
DEC 97		42.00	1.00000	0.00000	42.00000	0.00000	14.51333	20,014

JAN 96 - DEC 96	188,584
JAN 97 - DEC 97	229,838
TOTAL	418,422

MODEL V: LEARNING CURVE MODEL

$Y = a + b(1 - 1/e^t)$

Y = Average Total Injections for the month
t = Month: 1,July 94; 2,Aug 94;...; 18,Dec 95
X = (1- 1/e^t)

MONTH	Y	t	X	YY	YX	XX	t	e^t	1/e^t	(1- 1/e^t)
JUL 94	4.83	1	0.63212	23.3289	3.05314	0.39958	1	2.72E+00	0.36788	0.63212
AUG 94	6.82	2	0.86466	46.5124	5.89701	0.74765	2	7.39E+00	0.13534	0.86466
SEP 94	6.23	3	0.95021	38.8129	5.91983	0.90290	3	2.01E+01	0.04979	0.95021
OCT 94	6.67	4	0.98168	44.4889	6.54783	0.96370	4	5.46E+01	0.01832	0.98168
NOV 94	8.18	5	0.99326	66.9124	8.12488	0.98657	5	1.48E+02	0.00674	0.99326
DEC 94	7.21	6	0.99752	51.9841	7.19213	0.99505	6	4.03E+02	0.00248	0.99752
JAN 95	8.19	7	0.99909	67.0761	8.18253	0.99818	7	1.10E+03	0.00091	0.99909
FEB 95	9.57	8	0.99966	91.5849	9.56679	0.99933	8	2.98E+03	0.00034	0.99966
MAR 95	9.03	9	0.99988	81.5409	9.02889	0.99975	9	8.10E+03	0.00012	0.99988
APR 95	8.65	10	0.99995	74.8225	8.64961	0.99991	10	2.20E+04	0.00005	0.99995
MAY 95	9.35	11	0.99998	87.4225	9.34984	0.99997	11	5.99E+04	0.00002	0.99998
JUN 95	8.89	12	0.99999	79.0321	8.88995	0.99999	12	1.63E+05	0.00001	0.99999
JUL 95	9.17	13	1.00000	84.0889	9.16998	1.00000	13	4.42E+05	0.00000	1.00000
AUG 95	9.58	14	1.00000	91.7764	9.57999	1.00000	14	1.20E+06	0.00000	1.00000
SEP 95	9.34	15	1.00000	87.2356	9.34000	1.00000	15	3.27E+06	0.00000	1.00000
OCT 95	9.19	16	1.00000	84.4561	9.19000	1.00000	16	8.89E+06	0.00000	1.00000
NOV 95	9.02	17	1.00000	81.3604	9.02000	1.00000	17	2.42E+07	0.00000	1.00000
DEC 95	9.12	18	1.00000	83.1744	9.12000	1.00000	18	6.57E+07	0.00000	1.00000
TOTAL	149.04	171	17.41802	1,265.6104	145.82240	16.99256				
MEAN	8.28	10	0.96767							

Syy = 31.55920 Sxy = 1.60117 Sxx = 0.13770

b = 11.62783 a = (2.97188)

SSTotal = 31.55920 SSRegn = 18.61809

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION	1	18.61809	18.61809	23.01886 **
ERROR	16	12.94111	0.80882	
TOTAL	17	31.55920		

RR = 58.99 %

MODEL V: LEARNING CURVE MODEL

MONTH	Y	t	X	EST(Y)	ERROR	(ERROR)^2	
JUL 94	4.83	1	0.63212	4.37831	(0.45169)	0.20402	
AUG 94	6.82	2	0.86466	7.08230	0.26230	0.06880	
SEP 94	6.23	3	0.95021	8.07704	1.84704	3.41154	
OCT 94	6.67	4	0.98168	8.44298	1.77298	3.14346	
NOV 94	8.18	5	0.99326	8.57760	0.39760	0.15809	
DEC 94	7.21	6	0.99752	8.62713	1.41713	2.00825	
JAN 95	8.19	7	0.99909	8.64535	0.45535	0.20734	
FEB 95	9.57	8	0.99966	8.65205	(0.91795)	0.84263	
MAR 95	9.03	9	0.99988	8.65452	(0.37548)	0.14099	
APR 95	8.65	10	0.99995	8.65542	0.00542	0.00003	
MAY 95	9.35	11	0.99998	8.65576	(0.69424)	0.48197	
JUN 95	8.89	12	0.99999	8.65588	(0.23412)	0.05481	
JUL 95	9.17	13	1.00000	8.65593	(0.51407)	0.26427	
AUG 95	9.58	14	1.00000	8.65594	(0.92406)	0.85388	
SEP 95	9.34	15	1.00000	8.65595	(0.68405)	0.46793	
OCT 95	9.19	16	1.00000	8.65595	(0.53405)	0.28521	
NOV 95	9.02	17	1.00000	8.65595	(0.36405)	0.13253	
DEC 95	9.12	18	1.00000	8.65595	(0.46405)	0.21534	
TOTAL	149.04	17	17.41802	149.04000	(0.00000)	12.94111	
MEAN	8.28	1	0.96767	12.42000	(0.00000)	0.80882	VARIANCE
						0.89934	STD DEV

REGN COEF a b
(2.97188) 11.62783

FORECASTS: PHASE I
NO. OF FACILITIES: 1,379

MONTH	t	X	EST(Y)	INJECTIONS
JAN 96	19.00	1.00000	8.65595	11,937
FEB 96	20.00	1.00000	8.65595	11,937
MAR 96	21.00	1.00000	8.65595	11,937
APR 96	22.00	1.00000	8.65595	11,937
MAY 96	23.00	1.00000	8.65595	11,937
JUN 96	24.00	1.00000	8.65595	11,937
JUL 96	25.00	1.00000	8.65595	11,937
AUG 96	26.00	1.00000	8.65595	11,937
SEP 96	27.00	1.00000	8.65595	11,937
OCT 96	28.00	1.00000	8.65595	11,937
NOV 96	29.00	1.00000	8.65595	11,937
DEC 96	30.00	1.00000	8.65595	11,937
JAN 97	31.00	1.00000	8.65595	11,937
FEB 97	32.00	1.00000	8.65595	11,937
MAR 97	33.00	1.00000	8.65595	11,937
APR 97	34.00	1.00000	8.65595	11,937
MAY 97	35.00	1.00000	8.65595	11,937
JUN 97	36.00	1.00000	8.65595	11,937
JUL 97	37.00	1.00000	8.65595	11,937
AUG 97	38.00	1.00000	8.65595	11,937
SEP 97	39.00	1.00000	8.65595	11,937
OCT 97	40.00	1.00000	8.65595	11,937
NOV 97	41.00	1.00000	8.65595	11,937
DEC 97	42.00	1.00000	8.65595	11,937
JAN 96 - DEC 96				143,239
JAN 97 - DEC 97				143,239
TOTAL				286,477

t	e^t	1/e^t	(1- 1/e^t)
19.00	1.78E+08	0.000000	1.00000
20.00	4.85E+08	0.000000	1.00000
21.00	1.32E+09	0.000000	1.00000
22.00	3.58E+09	0.000000	1.00000
23.00	9.74E+09	0.000000	1.00000
24.00	2.65E+10	0.000000	1.00000
25.00	7.20E+10	0.000000	1.00000
26.00	1.96E+11	0.000000	1.00000
27.00	5.32E+11	0.000000	1.00000
28.00	1.45E+12	0.000000	1.00000
29.00	3.93E+12	0.000000	1.00000
30.00	1.07E+13	0.000000	1.00000
31.00	2.90E+13	0.000000	1.00000
32.00	7.90E+13	0.000000	1.00000
33.00	2.15E+14	0.000000	1.00000
34.00	5.83E+14	0.000000	1.00000
35.00	1.59E+15	0.000000	1.00000
36.00	4.31E+15	0.000000	1.00000
37.00	1.17E+16	0.000000	1.00000
38.00	3.19E+16	0.000000	1.00000
39.00	8.66E+16	0.000000	1.00000
40.00	2.35E+17	0.000000	1.00000
41.00	6.40E+17	0.000000	1.00000
42.00	1.74E+18	0.000000	1.00000

MODEL VI: LEARNING CURVE CUM LAGGED MODEL

Y = a + b1X1 + b2X2 + e

Y = Average Total Injections for the month
t = Month: 1,July 94; 2,Aug 94;...; 18,Dec 95
X1 = (1 - 1/e^t)
X2 = Average Total Injections 3 months earlier

MONTH	Y	t	X1	X2	YY	YX1	YX2	X1X1	X1X2	X2X2
JUL 94	4.83	1	0.63212	0.00	23.3289	3.05314	0.0000	0.39958	0.00000	0.0000
AUG 94	6.82	2	0.86466	0.00	46.5124	5.89701	0.0000	0.74765	0.00000	0.0000
SEP 94	6.23	3	0.95021	0.00	38.8129	5.91983	0.0000	0.90290	0.00000	0.0000
OCT 94	6.67	4	0.98168	4.83	44.4889	6.54783	32.2161	0.96370	4.74154	23.3289
NOV 94	8.18	5	0.99326	6.82	66.9124	8.12488	55.7876	0.98657	6.77405	46.5124
DEC 94	7.21	6	0.99752	6.23	51.9841	7.19213	44.9183	0.99505	6.21456	38.8129
JAN 95	8.19	7	0.99909	6.67	67.0761	8.18253	54.6273	0.99818	6.66392	44.4889
FEB 95	9.57	8	0.99966	8.18	91.5849	9.56679	78.2826	0.99933	8.17726	66.9124
MAR 95	9.03	9	0.99988	7.21	81.5409	9.02889	65.1063	0.99975	7.20911	51.9841
APR 95	8.65	10	0.99995	8.19	74.8225	8.64961	70.8435	0.99991	8.18963	67.0761
MAY 95	9.35	11	0.99998	9.57	87.4225	9.34984	89.4795	0.99997	9.56984	91.5849
JUN 95	8.89	12	0.99999	9.03	79.0321	8.88995	80.2767	0.99999	9.02994	81.5409
JUL 95	9.17	13	1.00000	8.65	84.0889	9.16998	79.3205	1.00000	8.64998	74.8225
AUG 95	9.58	14	1.00000	9.35	91.7764	9.57999	89.5730	1.00000	9.34999	87.4225
SEP 95	9.34	15	1.00000	8.89	87.2356	9.34000	83.0326	1.00000	8.89000	79.0321
OCT 95	9.19	16	1.00000	9.17	84.4561	9.19000	84.2723	1.00000	9.17000	84.0889
NOV 95	9.02	17	1.00000	9.58	81.3604	9.02000	86.4116	1.00000	9.58000	91.7764
DEC 95	9.12	18	1.00000	9.34	83.1744	9.12000	85.1808	1.00000	9.34000	87.2356
TOTAL	149.04	171	17.41802	121.71	1,265.6104	145.82240	1,079.3287	16.99256	121.54981	1,016.6195
MEAN	8.28	9.50	0.96767	6.76						

	X1	X2	Y	b	bSxy	SSR	SST	SSE	RR
X1	0.13770	3.77494	1.60117	3.21385	5.14590				
X2		193.65705	71.56990	0.30692	21.96646	27.11236	31.55920	4.44684	85.91
A1	0.13770	3.77494	1.60117						
B1	1.00000	27.41399	11.62783	3.21385	18.61809				
A2		90.17096	27.67555						
B2		1.00000	0.30692	0.30692	8.49427	27.11236	31.55920	4.44684	85.91

a = 3.09475

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION				
X1-X2	2	27.11236	13.55618	45.72747 **
X1	1	18.61809	18.61809	62.80222 **
X2	1	8.49427	8.49427	28.65271 **
ERROR	15	4.44684	0.29646	
TOTAL	17	31.55920		

RR	85.91 %
RR X1	58.99 %
RR X2	26.92 %

a	b1	b2
3.09475	3.21385	0.30692

MODEL VI: LEARNING CURVE CUM LAGGED MODEL

MONTH	Y	t	X1	X2	EST(Y)	ERROR	(ERROR)^2	FACILITIES	INJECTIONS	% FAC
JUL 94	4.83	1	0.63212	0.00	5.12629	0.29629	0.08779	921	4,721	66.79
AUG 94	6.82	2	0.86466	0.00	5.87365	(0.94635)	0.89558	1,098	6,449	79.62
SEP 94	6.23	3	0.95021	0.00	6.14859	(0.08141)	0.00663	1,180	7,255	85.57
OCT 94	6.67	4	0.98168	4.83	7.73217	1.06217	1.12821	1,205	9,317	87.38
NOV 94	8.18	5	0.99326	6.82	8.38016	0.20016	0.04006	1,226	10,274	88.91
DEC 94	7.21	6	0.99752	6.23	8.21276	1.00276	1.00553	1,244	10,217	90.21
JAN 95	8.19	7	0.99909	6.67	8.35284	0.16284	0.02652	1,298	10,842	94.13
FEB 95	9.57	8	0.99966	8.18	8.81815	(0.75185)	0.56528	1,321	11,649	95.79
MAR 95	9.03	9	0.99988	7.21	8.52112	(0.50888)	0.25896	1,349	11,495	97.82
APR 95	8.65	10	0.99995	8.19	8.82215	0.17215	0.02964	1,365	12,042	98.98
MAY 95	9.35	11	0.99998	9.57	9.24580	(0.10420)	0.01086	1,375	12,713	99.71
JUN 95	8.89	12	0.99999	9.03	9.08009	0.19009	0.03614	1,379	12,521	100.00
JUL 95	9.17	13	1.00000	8.65	8.96348	(0.20652)	0.04265	1,379	12,361	100.00
AUG 95	9.58	14	1.00000	9.35	9.17833	(0.40167)	0.16134	1,379	12,657	100.00
SEP 95	9.34	15	1.00000	8.89	9.03714	(0.30286)	0.09172	1,379	12,462	100.00
OCT 95	9.19	16	1.00000	9.17	9.12308	(0.06692)	0.00448	1,379	12,581	100.00
NOV 95	9.02	17	1.00000	9.58	9.24892	0.22892	0.05241	1,379	12,754	100.00
DEC 95	9.12	18	1.00000	9.34	9.17526	0.05526	0.00305	1,379	12,653	100.00
TOTAL	149.04	171	17.41802	121.71	149.04000	(0.00000)	4.44684	23,235	194,964	
MEAN	8.28	9.50	0.96767	6.76	8.28000	(0.00000)	0.29646	VARIANCE	10,831	
							0.54448	STD DEV		

JUL 94 - DEC 94	48,234
JAN 95 - DEC 95	146,730

REGN COEF	a	b1	b2
	3.09475	3.21385	0.30692

MODEL VI: LEARNING CURVE CUM LAGGED MODEL
FORECASTS: PHASE I
NO. OF FACILITIES: 1,379

MONTH	t	X1	X2	EST(Y)	INJECTIONS
JAN 96	19	1.00000	9.17	9.12308	12,581
FEB 96	20	1.00000	9.58	9.24892	12,754
MAR 96	21	1.00000	9.34	9.17526	12,653
APR 96	22	1.00000	9.12	9.10868	12,561
MAY 96	23	1.00000	9.25	9.14731	12,614
JUN 96	24	1.00000	9.18	9.12470	12,583
JUL 96	25	1.00000	9.11	9.10426	12,555
AUG 96	26	1.00000	9.15	9.11612	12,571
SEP 96	27	1.00000	9.12	9.10918	12,562
OCT 96	28	1.00000	9.10	9.10291	12,553
NOV 96	29	1.00000	9.12	9.10655	12,558
DEC 96	30	1.00000	9.11	9.10442	12,555
JAN 97	31	1.00000	9.10	9.10249	12,552
FEB 97	32	1.00000	9.11	9.10361	12,554
MAR 97	33	1.00000	9.10	9.10295	12,553
APR 97	34	1.00000	9.10	9.10236	12,552
MAY 97	35	1.00000	9.10	9.10271	12,553
JUN 97	36	1.00000	9.10	9.10251	12,552
JUL 97	37	1.00000	9.10	9.10232	12,552
AUG 97	38	1.00000	9.10	9.10243	12,552
SEP 97	39	1.00000	9.10	9.10237	12,552
OCT 97	40	1.00000	9.10	9.10231	12,552
NOV 97	41	1.00000	9.10	9.10234	12,552
DEC 97	42	1.00000	9.10	9.10233	12,552
JAN 98	43	1.00000	9.10	9.10231	12,552
FEB 98	44	1.00000	9.10	9.10232	12,552
MAR 98	45	1.00000	9.10	9.10231	12,552
APR 98	46	1.00000	9.10	9.10231	12,552
MAY 98	47	1.00000	9.10	9.10231	12,552
JUN 98	48	1.00000	9.10	9.10231	12,552
JUL 98	49	1.00000	9.10	9.10231	12,552
AUG 98	50	1.00000	9.10	9.10231	12,552
SEP 98	51	1.00000	9.10	9.10231	12,552
OCT 98	52	1.00000	9.10	9.10231	12,552
NOV 98	53	1.00000	9.10	9.10231	12,552
DEC 98	54	1.00000	9.10	9.10231	12,552

JAN 96 - DEC 96	151,099
JAN 97 - DEC 97	150,629
JAN 98 - DEC 98	150,625
TOTAL	452,353

REGN COEF	a	b1	b2
	3.09475	3.21385	0.30692

MODEL VI: LEARNING CURVE CUM LAGGED MODEL
FORECASTS: PHASE II
NO. OF FACILITIES: 4,097

MONTH	t	X1	X2	EST(Y)	INJECTIONS	% FAC REV	INJECT
JAN 95	1	0.63212	0.00	5.12629	21,002	66.79	14,027
FEB 95	2	0.86466	0.00	5.87365	24,064	79.62	19,161
MAR 95	3	0.95021	0.00	6.14859	25,191	85.57	21,556
APR 95	4	0.98168	5.13	7.82311	32,051	87.38	28,007
MAY 95	5	0.99326	5.87	8.08970	33,144	88.91	29,466
JUN 95	6	0.99752	6.15	8.18778	33,545	90.21	30,261
JUL 95	7	0.99909	7.82	8.70676	35,672	94.13	33,576
AUG 95	8	0.99966	8.09	8.79044	36,014	95.79	34,500
SEP 95	9	0.99988	8.19	8.82172	36,141	97.82	35,354
OCT 95	10	0.99995	8.71	8.98076	36,794	98.98	36,421
NOV 95	11	0.99998	8.79	9.00653	36,900	99.71	36,793
DEC 95	12	0.99999	8.82	9.01601	36,939	100.00	36,939
JAN 96	13	1.00000	8.98	9.06499	37,139	100.00	37,139
FEB 96	14	1.00000	9.01	9.07291	37,172	100.00	37,172
MAR 96	15	1.00000	9.02	9.07582	37,184	100.00	37,184
APR 96	16	1.00000	9.06	9.09085	37,245	100.00	37,245
MAY 96	17	1.00000	9.07	9.09328	37,255	100.00	37,255
JUN 96	18	1.00000	9.08	9.09418	37,259	100.00	37,259
JUL 96	19	1.00000	9.09	9.09879	37,278	100.00	37,278
AUG 96	20	1.00000	9.09	9.09954	37,281	100.00	37,281
SEP 96	21	1.00000	9.09	9.09981	37,282	100.00	37,282
OCT 96	22	1.00000	9.10	9.10123	37,288	100.00	37,288
NOV 96	23	1.00000	9.10	9.10146	37,289	100.00	37,289
DEC 96	24	1.00000	9.10	9.10154	37,289	100.00	37,289
JAN 97	25	1.00000	9.10	9.10198	37,291	100.00	37,291
FEB 97	26	1.00000	9.10	9.10205	37,291	100.00	37,291
MAR 97	27	1.00000	9.10	9.10207	37,291	100.00	37,291
APR 97	28	1.00000	9.10	9.10221	37,292	100.00	37,292
MAY 97	29	1.00000	9.10	9.10223	37,292	100.00	37,292
JUN 97	30	1.00000	9.10	9.10223	37,292	100.00	37,292
JUL 97	31	1.00000	9.10	9.10228	37,292	100.00	37,292
AUG 97	32	1.00000	9.10	9.10228	37,292	100.00	37,292
SEP 97	33	1.00000	9.10	9.10228	37,292	100.00	37,292
OCT 97	34	1.00000	9.10	9.10230	37,292	100.00	37,292
NOV 97	35	1.00000	9.10	9.10230	37,292	100.00	37,292
DEC 97	36	1.00000	9.10	9.10230	37,292	100.00	37,292
JAN 98	37	1.00000	9.10	9.10230	37,292	100.00	37,292
FEB 98	38	1.00000	9.10	9.10230	37,292	100.00	37,292
MAR 98	39	1.00000	9.10	9.10230	37,292	100.00	37,292
APR 98	40	1.00000	9.10	9.10231	37,292	100.00	37,292
MAY 98	41	1.00000	9.10	9.10231	37,292	100.00	37,292
JUN 98	42	1.00000	9.10	9.10231	37,292	100.00	37,292
JUL 98	43	1.00000	9.10	9.10231	37,292	100.00	37,292
AUG 98	44	1.00000	9.10	9.10231	37,292	100.00	37,292
SEP 98	45	1.00000	9.10	9.10231	37,292	100.00	37,292
OCT 98	46	1.00000	9.10	9.10231	37,292	100.00	37,292
NOV 98	47	1.00000	9.10	9.10231	37,292	100.00	37,292
DEC 98	48	1.00000	9.10	9.10231	37,292	100.00	37,292

JAN 95 - DEC 95	387,457	356,060
JAN 96 - DEC 96	446,960	446,960
JAN 97 - DEC 97	447,501	447,501
JAN 98 - DEC 98	447,506	447,506
SUB-TOTAL	1,341,967	1,341,967
TOTAL, PHASE II	1,729,423	1,698,027

REG COEFF	a	b1	b2
	3.09475	3.21385	0.30692

MODEL VI: LEARNING CURVE CUM LAGGED MODEL
FORECASTS: PHASE III
NO. OF FACILITIES: 4,712

MONTH	t	X1	X2	EST(Y)	INJECTIONS	% FAC	REV INJ
OCT 95	1	0.63212	0.00	5.12629	24,155	66.79	16,133
NOV 95	2	0.86466	0.00	5.87365	27,677	79.62	22,037
DEC 95	3	0.95021	0.00	6.14859	28,972	85.57	24,791
JAN 96	4	0.98168	5.13	7.82311	36,863	87.38	32,211
FEB 96	5	0.99326	5.87	8.08970	38,119	88.91	33,889
MAR 96	6	0.99752	6.15	8.18778	38,581	90.21	34,804
APR 96	7	0.99909	7.82	8.70676	41,026	94.13	38,616
MAY 96	8	0.99966	8.09	8.79044	41,421	95.79	39,678
JUN 96	9	0.99988	8.19	8.82122	41,566	97.82	40,661
JUL 96	10	0.99995	8.71	8.98076	42,317	98.98	41,888
AUG 96	11	0.99998	8.79	9.00653	42,439	99.71	42,316
SEP 96	12	0.99999	8.82	9.01601	42,483	100.00	42,483
OCT 96	13	1.00000	8.98	9.06499	42,714	100.00	42,714
NOV 96	14	1.00000	9.01	9.07291	42,752	100.00	42,752
DEC 96	15	1.00000	9.02	9.07582	42,765	100.00	42,765
JAN 97	16	1.00000	9.06	9.09085	42,836	100.00	42,836
FEB 97	17	1.00000	9.07	9.09328	42,848	100.00	42,848
MAR 97	18	1.00000	9.08	9.09418	42,852	100.00	42,852
APR 97	19	1.00000	9.09	9.09879	42,874	100.00	42,874
MAY 97	20	1.00000	9.09	9.09954	42,877	100.00	42,877
JUN 97	21	1.00000	9.09	9.09981	42,878	100.00	42,878
JUL 97	22	1.00000	9.10	9.10123	42,885	100.00	42,885
AUG 97	23	1.00000	9.10	9.10146	42,886	100.00	42,886
SEP 97	24	1.00000	9.10	9.10154	42,886	100.00	42,886
OCT 97	25	1.00000	9.10	9.10198	42,889	100.00	42,889
NOV 97	26	1.00000	9.10	9.10205	42,889	100.00	42,889
DEC 97	27	1.00000	9.10	9.10207	42,889	100.00	42,889
JAN 98	28	1.00000	9.10	9.10221	42,890	100.00	42,890
FEB 98	29	1.00000	9.10	9.10223	42,890	100.00	42,890
MAR 98	30	1.00000	9.10	9.10223	42,890	100.00	42,890
APR 98	31	1.00000	9.10	9.10228	42,890	100.00	42,890
MAY 98	32	1.00000	9.10	9.10228	42,890	100.00	42,890
JUN 98	33	1.00000	9.10	9.10228	42,890	100.00	42,890
JUL 98	34	1.00000	9.10	9.10230	42,890	100.00	42,890
AUG 98	35	1.00000	9.10	9.10230	42,890	100.00	42,890
SEP 98	36	1.00000	9.10	9.10230	42,890	100.00	42,890
OCT 98	37	1.00000	9.10	9.10230	42,890	100.00	42,890
NOV 98	38	1.00000	9.10	9.10230	42,890	100.00	42,890
DEC 98	39	1.00000	9.10	9.10230	42,890	100.00	42,890

OCT 95 - DEC 95	80,804	62,961
JAN 96 - DEC 96	493,045	474,779
JAN 97 - DEC 97	514,488	514,488
JAN 98 - DEC 98	514,679	514,679
SUB-TOTAL	1,522,212	1,503,946
TOTAL, PHASE III	1,603,016	1,566,907

REVISED ESTIMATES

REGN COEF	a	b1	b2
	3.09475	3.21385	0.30692

FORECASTS: PHASE II
NO. OF FACILITIES: 3,518

MONTH	t	X1	X2	EST(Y)	INJECTIONS	% FAC REV	INJECT
JAN 95	1	0.63212	0.00	5.12629	18,034	66.79	12,045
FEB 95	2	0.86466	0.00	5.87365	20,664	79.62	16,453
MAR 95	3	0.95021	0.00	6.14859	21,631	85.57	18,509
APR 95	4	0.98168	5.13	7.82311	27,522	87.38	24,049
MAY 95	5	0.99326	5.87	8.08970	28,460	88.91	25,302
JUN 95	6	0.99752	6.15	8.18778	28,805	90.21	25,985
JUL 95	7	0.99909	7.82	8.70676	30,630	94.13	28,831
AUG 95	8	0.99966	8.09	8.79044	30,925	95.79	29,624
SEP 95	9	0.99988	8.19	8.82122	31,033	97.82	30,358
OCT 95	10	0.99995	8.71	8.98076	31,594	98.98	31,274
NOV 95	11	0.99998	8.79	9.00653	31,685	99.71	31,593
DEC 95	12	0.99999	8.82	9.01601	31,718	100.00	31,718
JAN 96	13	1.00000	8.98	9.06499	31,891	100.00	31,891
FEB 96	14	1.00000	9.01	9.07291	31,918	100.00	31,918
MAR 96	15	1.00000	9.02	9.07582	31,929	100.00	31,929
APR 96	16	1.00000	9.06	9.09085	31,982	100.00	31,982
MAY 96	17	1.00000	9.07	9.09328	31,990	100.00	31,990
JUN 96	18	1.00000	9.08	9.09418	31,993	100.00	31,993
JUL 96	19	1.00000	9.09	9.09879	32,010	100.00	32,010
AUG 96	20	1.00000	9.09	9.09954	32,012	100.00	32,012
SEP 96	21	1.00000	9.09	9.09981	32,013	100.00	32,013
OCT 96	22	1.00000	9.10	9.10123	32,018	100.00	32,018
NOV 96	23	1.00000	9.10	9.10146	32,019	100.00	32,019
DEC 96	24	1.00000	9.10	9.10154	32,019	100.00	32,019
JAN 97	25	1.00000	9.10	9.10198	32,021	100.00	32,021
FEB 97	26	1.00000	9.10	9.10205	32,021	100.00	32,021
MAR 97	27	1.00000	9.10	9.10207	32,021	100.00	32,021
APR 97	28	1.00000	9.10	9.10221	32,022	100.00	32,022
MAY 97	29	1.00000	9.10	9.10223	32,022	100.00	32,022
JUN 97	30	1.00000	9.10	9.10223	32,022	100.00	32,022
JUL 97	31	1.00000	9.10	9.10228	32,022	100.00	32,022
AUG 97	32	1.00000	9.10	9.10228	32,022	100.00	32,022
SEP 97	33	1.00000	9.10	9.10228	32,022	100.00	32,022
OCT 97	34	1.00000	9.10	9.10230	32,022	100.00	32,022
NOV 97	35	1.00000	9.10	9.10230	32,022	100.00	32,022
DEC 97	36	1.00000	9.10	9.10230	32,022	100.00	32,022
JAN 98	37	1.00000	9.10	9.10230	32,022	100.00	32,022
FEB 98	38	1.00000	9.10	9.10230	32,022	100.00	32,022
MAR 98	39	1.00000	9.10	9.10230	32,022	100.00	32,022
APR 98	40	1.00000	9.10	9.10231	32,022	100.00	32,022
MAY 98	41	1.00000	9.10	9.10231	32,022	100.00	32,022
JUN 98	42	1.00000	9.10	9.10231	32,022	100.00	32,022
JUL 98	43	1.00000	9.10	9.10231	32,022	100.00	32,022
AUG 98	44	1.00000	9.10	9.10231	32,022	100.00	32,022
SEP 98	45	1.00000	9.10	9.10231	32,022	100.00	32,022
OCT 98	46	1.00000	9.10	9.10231	32,022	100.00	32,022
NOV 98	47	1.00000	9.10	9.10231	32,022	100.00	32,022
DEC 98	48	1.00000	9.10	9.10231	32,022	100.00	32,022

JAN 95 - DEC 95	332,700	305,741
JAN 96 - DEC 96	383,794	383,794
JAN 97 - DEC 97	384,259	384,259
JAN 98 - DEC 98	384,263	384,263
SUB-TOTAL	1,152,316	1,152,316
TOTAL, PHASE II	1,485,016	1,458,057

REG COEFF	a	b1	b2
	3.09475	3.21385	0.30692

FORECASTS: PHASE III
NO. OF FACILITIES: 1,617

MONTH	t	X1	X2	EST(Y)	INJECTIONS	% FAC	REV INJ
OCT 95	1	0.63212	0.00	5.12629	8,289	66.79	5,536
NOV 95	2	0.86466	0.00	5.87365	9,498	79.62	7,562
DEC 95	3	0.95021	0.00	6.14859	9,942	85.57	8,508
JAN 96	4	0.98168	5.13	7.82311	12,650	87.38	11,054
FEB 96	5	0.99326	5.87	8.08970	13,081	88.91	11,630
MAR 96	6	0.99752	6.15	8.18778	13,240	90.21	11,944
APR 96	7	0.99909	7.82	8.70676	14,079	94.13	13,252
MAY 96	8	0.99966	8.09	8.79044	14,214	95.79	13,616
JUN 96	9	0.99988	8.19	8.82122	14,264	97.82	13,954
JUL 96	10	0.99995	8.71	8.98076	14,522	98.98	14,374
AUG 96	11	0.99998	8.79	9.00653	14,564	99.71	14,521
SEP 96	12	0.99999	8.82	9.01601	14,579	100.00	14,579
OCT 96	13	1.00000	8.98	9.06499	14,658	100.00	14,658
NOV 96	14	1.00000	9.01	9.07291	14,671	100.00	14,671
DEC 96	15	1.00000	9.02	9.07582	14,676	100.00	14,676
JAN 97	16	1.00000	9.06	9.09085	14,700	100.00	14,700
FEB 97	17	1.00000	9.07	9.09328	14,704	100.00	14,704
MAR 97	18	1.00000	9.08	9.09418	14,705	100.00	14,705
APR 97	19	1.00000	9.09	9.09879	14,713	100.00	14,713
MAY 97	20	1.00000	9.09	9.09954	14,714	100.00	14,714
JUN 97	21	1.00000	9.09	9.09981	14,714	100.00	14,714
JUL 97	22	1.00000	9.10	9.10123	14,717	100.00	14,717
AUG 97	23	1.00000	9.10	9.10146	14,717	100.00	14,717
SEP 97	24	1.00000	9.10	9.10154	14,717	100.00	14,717
OCT 97	25	1.00000	9.10	9.10198	14,718	100.00	14,718
NOV 97	26	1.00000	9.10	9.10205	14,718	100.00	14,718
DEC 97	27	1.00000	9.10	9.10207	14,718	100.00	14,718
JAN 98	28	1.00000	9.10	9.10221	14,718	100.00	14,718
FEB 98	29	1.00000	9.10	9.10223	14,718	100.00	14,718
MAR 98	30	1.00000	9.10	9.10223	14,718	100.00	14,718
APR 98	31	1.00000	9.10	9.10228	14,718	100.00	14,718
MAY 98	32	1.00000	9.10	9.10228	14,718	100.00	14,718
JUN 98	33	1.00000	9.10	9.10228	14,718	100.00	14,718
JUL 98	34	1.00000	9.10	9.10230	14,718	100.00	14,718
AUG 98	35	1.00000	9.10	9.10230	14,718	100.00	14,718
SEP 98	36	1.00000	9.10	9.10230	14,718	100.00	14,718
OCT 98	37	1.00000	9.10	9.10230	14,718	100.00	14,718
NOV 98	38	1.00000	9.10	9.10230	14,718	100.00	14,718
DEC 98	39	1.00000	9.10	9.10230	14,718	100.00	14,718

OCT 95 - DEC 95	27,729	21,606
JAN 96 - DEC 96	169,196	162,928
JAN 97 - DEC 97	176,555	176,555
JAN 98 - DEC 98	176,621	176,621
SUB-TOTAL	522,372	516,104
TOTAL, PHASE III	550,101	537,710

MODEL VII: LEARNING CURVE COM SINUSOIDAL MODEL

Y = a + b1X1 + b2X2 + b3X3 + b4X4 + b5X5 + e

Y = Average Total Injections for the month
t = Month: 1,July 94; 2,Aug 94;...; 18,Dec 95
X1 = (1 - 1/e^t)
X2 = Cos (2 t/3)
X3 = Sin (2 t/3)
X4 = t Cos (2 t/3)
X5 = t Sin (2 t/3)

MONTH	Y	t	X1	X2	X3	X4	X5	YY	YX1	YX2	YX3	YX4	YX5	X1X1
JUL 94	4.83	1	0.63212	(0.50)	0.86602	(0.50)	0.86602	23.3289	3.05314	(2.415)	4.18288	(2.415)	4.18288	0.39958
AUG 94	6.82	2	0.86466	(0.50)	(0.86602)	(1.00)	(1.73204)	46.5124	5.89701	(3.410)	(5.90626)	(6.820)	(11.81251)	0.74765
SEP 94	6.23	3	0.95021	1.00	0.00000	3.00	0.00000	38.8129	5.91983	6.230	0.00000	18.690	0.00000	0.90290
OCT 94	6.67	4	0.98168	(0.50)	0.86602	(2.00)	3.46408	44.4889	6.54783	(3.335)	5.77635	(13.340)	23.10541	0.96370
NOV 94	8.19	5	0.99326	(0.50)	(0.86602)	(2.50)	(4.33010)	66.9124	8.12488	(4.095)	(7.08404)	(20.450)	(35.42022)	0.98657
DEC 94	7.21	6	0.99752	1.00	0.00000	6.00	0.00000	51.9841	7.19213	7.210	0.00000	43.260	0.00000	0.99505
JAN 95	8.19	7	0.99909	(0.50)	0.86602	(3.50)	6.06214	67.0761	8.18253	(4.095)	7.09270	(28.665)	49.64893	0.99818
FEB 95	9.57	8	0.99966	(0.50)	(0.86602)	(4.00)	(6.92816)	91.5849	9.56679	(4.785)	(8.28781)	(38.280)	(66.30249)	0.99933
MAR 95	9.03	9	0.99988	1.00	0.00000	9.00	0.00000	81.5409	9.02889	9.030	0.00000	81.270	0.00000	0.99975
APR 95	8.65	10	0.99995	(0.50)	0.86602	(5.00)	8.66020	74.8225	8.64961	(4.325)	7.49107	(43.250)	74.91073	0.99991
MAY 95	9.35	11	0.99998	(0.50)	(0.86602)	(5.50)	(9.52622)	87.4225	9.34984	(4.675)	(8.09729)	(51.425)	(89.07016)	0.99997
JUN 95	8.89	12	0.99999	1.00	0.00000	12.00	0.00000	79.0321	8.88995	8.890	0.00000	106.680	0.00000	0.99999
JUL 95	9.17	13	1.00000	(0.50)	0.86602	(6.50)	11.25826	84.0889	9.16998	(4.585)	7.94140	(59.605)	103.23824	1.00000
AUG 95	9.58	14	1.00000	(0.50)	(0.86602)	(7.00)	(12.12428)	91.7764	9.57999	(4.790)	(8.29647)	(67.060)	(116.15060)	1.00000
SEP 95	9.34	15	1.00000	1.00	0.00000	15.00	0.00000	87.2356	9.34000	9.340	0.00000	140.100	0.00000	1.00000
OCT 95	9.19	16	1.00000	(0.50)	0.86602	(8.00)	13.85632	84.4561	9.19000	(4.595)	7.95872	(73.520)	127.33958	1.00000
NOV 95	9.02	17	1.00000	(0.50)	(0.86602)	(8.50)	(14.72234)	81.3604	9.02000	(4.510)	(7.81150)	(76.670)	(132.79551)	1.00000
DEC 95	9.12	18	1.00000	1.00	0.00000	18.00	0.00000	83.1744	9.12000	9.120	0.00000	164.160	0.00000	1.00000
TOTAL	149.04	171	17.41802	0.00	0.00000	9.00	(5.19612)	1,265.6104	145.82240	0.210	(5.04024)	72.660	(69.12572)	16.99256
MEAN	8.28	9.50	0.96767	0.00	0.00000	0.50	(0.28867)							

MONTH	X1X2	X1X3	X1X4	X1X5	X2X2	X2X3	X2X4	X2X5	X3X3	X3X4	X3X5	X4X4	X4X5	X5X5
JUL 94	(0.31606)	0.54743	(0.31606)	0.54743	0.25	(0.43301)	0.25	(0.43301)	0.74999	(0.43301)	0.74999	0.25	(0.43301)	0.74999
AUG 94	(0.43233)	(0.74882)	(0.86466)	(1.49763)	0.25	0.43301	0.50	0.86602	0.74999	0.86602	1.49998	1.00	1.73204	2.99996
SEP 94	0.95021	0.00000	2.85064	0.00000	1.00	0.00000	3.00	0.00000	0.00000	0.00000	0.00000	9.00	0.00000	0.00000
OCT 94	(0.49084)	0.85016	(1.96337)	3.40063	0.25	(0.43301)	1.00	(1.73204)	0.74999	(1.73204)	2.99996	4.00	(6.92816)	11.99985
NOV 94	(0.49663)	(0.86018)	(2.48316)	(4.30092)	0.25	0.43301	1.25	2.16505	0.74999	2.16505	3.74995	6.25	10.82525	18.74977
DEC 94	0.99752	0.00000	5.98513	0.00000	1.00	0.00000	6.00	0.00000	0.00000	0.00000	0.00000	36.00	0.00000	0.00000
JAN 95	(0.49954)	0.86523	(3.49681)	6.05661	0.25	(0.43301)	1.75	(3.03107)	0.74999	(3.03107)	5.24993	12.25	(21.21749)	36.74954
FEB 95	(0.49983)	(0.86573)	(3.99866)	(6.92584)	0.25	0.43301	2.00	3.46408	0.74999	3.46408	5.99993	16.00	27.71264	47.99940
MAR 95	0.99988	0.00000	8.99889	0.00000	1.00	0.00000	9.00	0.00000	0.00000	0.00000	0.00000	81.00	0.00000	0.00000
APR 95	(0.49998)	0.86598	(4.99977)	8.65981	0.25	(0.43301)	2.50	(4.33010)	0.74999	(4.33010)	7.49991	25.00	(43.30100)	74.99906
MAY 95	(0.49999)	(0.86601)	(5.49991)	(9.52606)	0.25	0.43301	2.75	4.76311	0.74999	4.76311	8.24990	30.25	52.39421	90.74887
JUN 95	0.99999	0.00000	11.99993	0.00000	1.00	0.00000	12.00	0.00000	0.00000	0.00000	0.00000	144.00	0.00000	0.00000
JUL 95	(0.50000)	0.86602	(6.49999)	11.25823	0.25	(0.43301)	3.25	(5.62913)	0.74999	(5.62913)	9.74988	42.25	(73.17869)	126.74842
AUG 95	(0.50000)	(0.86602)	(6.99999)	(12.12427)	0.25	0.43301	3.50	6.06214	0.74999	6.06214	10.49987	49.00	84.86996	146.99817
SEP 95	1.00000	0.00000	15.00000	0.00000	1.00	0.00000	15.00	0.00000	0.00000	0.00000	0.00000	225.00	0.00000	0.00000
OCT 95	(0.50000)	0.86602	(8.00000)	13.85632	0.25	(0.43301)	4.00	(6.92816)	0.74999	(6.92816)	11.99985	64.00	(110.85056)	191.99760
NOV 95	(0.50000)	(0.86602)	(8.50000)	(14.72234)	0.25	0.43301	4.25	7.36117	0.74999	7.36117	12.74984	72.25	125.13989	216.74730
DEC 95	1.00000	0.00000	18.00000	0.00000	1.00	0.00000	18.00	0.00000	0.00000	0.00000	0.00000	324.00	0.00000	0.00000
TOTAL	0.21239	(0.21194)	9.21220	(5.31803)	9.00	0.00000	90.00	2.59906	3.99989	2.59906	30.99899	1,141.50	46.76508	967.48795

	X1	X2	X3	X4	X5	Y	b	bSxy	SSR	SST	SSE	RR
X1	0.13770	0.21239	(0.21194)	0.50319	(0.28991)	1.60117	12.45444	19.94163				
X2		9.00000	0.00000	90.00000	2.59806	0.21000	(0.93649)	(0.20716)				
X3			8.99999	2.59806	80.99899	(5.04024)	(0.28047)	1.41362				
X4				1,137.00000	49.36314	(1.86000)	0.07161	(0.13320)				
X5					965.98794	(26.10184)	(0.00077)	0.02015	21.03504	31.55920	10.52416	66.65264
A1	0.13770	0.21239	(0.21194)	0.50319	(0.28991)	1.60117						
B1	1.00000	1.54243	(1.53913)	3.65422	(2.10536)	11.62793	12.45444	18.61809				
A2		8.67240	0.32690	89.22386	3.04523	(2.25969)						
B2		1.00000	0.03769	10.28826	0.35114	(0.26056)	(0.93649)	0.58879				
A3			8.66136	0.00927	80.43799	(2.49066)						
B3			1.00000	0.00107	9.28699	(0.28756)	(0.28047)	0.71621				
A4				217.20237	19.00632	15.53995						
B4				1.00000	0.08750	0.07155	0.07161	1.11182				
A5					215.61831	(0.16644)						
B5					1.00000	(0.00077)	(0.00077)	0.00013	21.03504	31.55920	10.52416	66.65264

a (3.80780)

ANOVA TABLE:

SOURCES OF VARIATION	df	SUM OF SQUARES	MEAN SQUARE	F
REGRESSION				
X1-X5	5	21.03504	4.20701	4.79697 NS
X1	1	18.61809	18.61809	21.22897 **
X2	1	0.58879	0.58879	0.67136 NS
X3	1	0.71621	0.71621	0.81665 NS
X4	1	1.11182	1.11182	1.26773 NS
X5	1	0.00013	0.00013	0.00015 NS
X2-X5	4	2.41695	0.60424	0.68897 NS
ERROR	12	10.52416	0.87701	
TOTAL	17	31.55920		

RR 66.65

RR X1 58.99

MODEL VII: LEARNING CURVE CUM SINUSOIDAL MODEL

MONTH	Y	t	X1	X2	X3	X4	X5	EST(Y)	ERROR	(ERROR)^2
JUL 94	4.83	1	0.63212	(0.50000)	0.86602	(0.50000)	0.86602	4.27880	(0.55120)	0.30383
AUG 94	6.82	2	0.86466	(0.50000)	(0.86602)	(1.00000)	(1.73204)	7.62698	0.80698	0.65122
SEP 94	6.23	3	0.95021	1.00000	0.00000	3.00000	0.00000	7.25492	1.02492	1.05047
OCT 94	6.67	4	0.98168	(0.50000)	0.86602	(2.00000)	3.46408	8.52299	1.85299	3.43358
NOV 94	8.18	5	0.99326	(0.50000)	(0.86602)	(2.50000)	(4.33010)	9.12318	0.94318	0.88958
DEC 94	7.21	6	0.99752	1.00000	0.00000	6.00000	0.00000	8.05896	0.84896	0.72074
JAN 95	8.19	7	0.99909	(0.50000)	0.86602	(3.50000)	6.06214	8.63032	0.44032	0.19388
FEB 95	9.57	8	0.99966	(0.50000)	(0.86602)	(4.00000)	(6.92816)	9.09750	(0.47250)	0.22325
MAR 95	9.03	9	0.99988	1.00000	0.00000	9.00000	0.00000	8.30314	(0.72686)	0.52833
APR 95	8.65	10	0.99995	(0.50000)	0.86602	(5.00000)	8.66020	8.53169	(0.11831)	0.01400
MAY 95	9.35	11	0.99998	(0.50000)	(0.86602)	(5.50000)	(9.52622)	8.99606	(0.35394)	0.12527
JUN 95	8.89	12	0.99999	1.00000	0.00000	12.00000	0.00000	8.51944	(0.37056)	0.13732
JUL 95	9.17	13	1.00000	(0.50000)	0.86602	(6.50000)	11.25826	8.42280	(0.74720)	0.55831
AUG 95	9.58	14	1.00000	(0.50000)	(0.86602)	(7.00000)	(12.12428)	8.89084	(0.68916)	0.47494
SEP 95	9.34	15	1.00000	1.00000	0.00000	15.00000	0.00000	8.73435	(0.60565)	0.36681
OCT 95	9.19	16	1.00000	(0.50000)	0.86602	(8.00000)	13.85632	8.31340	(0.87660)	0.76843
NOV 95	9.02	17	1.00000	(0.50000)	(0.86602)	(8.50000)	(14.72234)	8.78544	(0.23456)	0.05502
DEC 95	9.12	18	1.00000	1.00000	0.00000	18.00000	0.00000	8.94919	(0.17081)	0.02918
TOTAL	149.04	171	17.41802	0.00000	0.00000	9.00000	(5.19612)	149.04000	(0.00000)	10.52416
MEAN	8.28	9.50	0.96767	0.00000	0.00000	0.50000	(0.28867)	12.42000	(0.00000)	0.87701 VARIANCE
										0.93649 STD DEV

REGRESSION COEFFICIENTS

a	b1	b2	b3	b4	b5
(3.90730)	12.45444	(0.98649)	(0.28047)	0.07161	(0.00077)

FORECASTS: PHASE I

NO. OF FACILITIES: 1,379

MONTH	t	X1	X2	X3	X4	X5	EST(Y)	INJECTIONS
JAN 96	19.00	1.00000	(0.50000)	0.86602	(9.50000)	16.45439	8.20398	11,313
FEB 96	20.00	1.00000	(0.50000)	(0.86602)	(10.00000)	(17.32040)	8.68002	11,970
MAR 96	21.00	1.00000	1.00000	0.00000	21.00000	0.00000	9.16403	12,637
APR 96	22.00	1.00000	(0.50000)	0.86602	(11.00000)	19.05244	8.09455	11,162
MAY 96	23.00	1.00000	(0.50000)	(0.86602)	(11.50000)	(19.91846)	8.57461	11,824
JUN 96	24.00	1.00000	1.00000	0.00000	24.00000	0.00000	9.37887	12,933
JUL 96	25.00	1.00000	(0.50000)	0.86602	(12.50000)	21.65050	7.98513	11,011
AUG 96	26.00	1.00000	(0.50000)	(0.86602)	(13.00000)	(22.51652)	8.46919	11,679
SEP 96	27.00	1.00000	1.00000	0.00000	27.00000	0.00000	9.59371	13,230
OCT 96	28.00	1.00000	(0.50000)	0.86602	(14.00000)	24.24856	7.87570	10,861
NOV 96	29.00	1.00000	(0.50000)	(0.86602)	(14.50000)	(25.11458)	8.36378	11,534
DEC 96	30.00	1.00000	1.00000	0.00000	30.00000	0.00000	9.80855	13,526
JAN 97	31.00	1.00000	(0.50000)	0.86602	(15.50000)	26.84662	7.76528	10,710
FEB 97	32.00	1.00000	(0.50000)	(0.86602)	(16.00000)	(27.71264)	8.25836	11,388
MAR 97	33.00	1.00000	1.00000	0.00000	33.00000	0.00000	10.02339	13,822
APR 97	34.00	1.00000	(0.50000)	0.86602	(17.00000)	29.44468	7.65685	10,559
MAY 97	35.00	1.00000	(0.50000)	(0.86602)	(17.50000)	(30.31070)	8.15295	11,243
JUN 97	36.00	1.00000	1.00000	0.00000	36.00000	0.00000	10.23823	14,119
JUL 97	37.00	1.00000	(0.50000)	0.86602	(18.50000)	32.04274	7.54742	10,408
AUG 97	38.00	1.00000	(0.50000)	(0.86602)	(19.00000)	(32.90876)	8.04754	11,099
SEP 97	39.00	1.00000	1.00000	0.00000	39.00000	0.00000	10.45307	14,415
OCT 97	40.00	1.00000	(0.50000)	0.86602	(20.00000)	34.64080	7.43900	10,257
NOV 97	41.00	1.00000	(0.50000)	(0.86602)	(20.50000)	(35.50682)	7.94212	10,952
DEC 97	42.00	1.00000	1.00000	0.00000	42.00000	0.00000	10.66791	14,711

JAN 96 - DEC 96	143,681
JAN 97 - DEC 97	143,681
TOTAL	287,362