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COMPUTER -AIDED ANALYSIS OF THE PERFORMANCE OF DIESEL GENEPATOR POWER SYSTEMS USED FOR WATER PUMPING

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ABSTRACT

The water Boards in the 36 states in Nigeria are constrained to utilize diesel generators for water pumping in the rural communities where grid electricity is unavailable. A software has been developed for the storage and analysis of some of the operational data of diesel generator-powered water pumping stations. The operational data include the monthly water production, diesel fuel consumption, engine oil consumption, number of days of operation within the month and the reasons for systems failure. For each station or a group of stations, it is possible, using the software, to generate information on the seasonal (rainy and dry season). water production , the average monthly, yearly and periodic production figures and the per-capita values. The average monthly /yearly down time over a period of years can be deduced. Results of the analysis of some water pumping stations are presented. The software is user-friendly and is designed to assist technical and managerial staff in assessing the performance of water pumping stations.

INTRODUCTION

Water supply and sanitation have for many years been environmental priorities to the World Health Organization(WHO) and the nations of the world. Poor sanitation and unsafe drinking water are known to be responsible for the several cholera and diarrhoea epidemics which have been rampant particularly in the overpopulated commmunities in Latin America and Africa(World Bank, 1992). These epidemics are caused mainly by the bacterial, viral and parasitic infestation transmitted through water. In Nigeria , the Federal Government through its national borehole programme is making efforts to facilitate the provision of clean drinking water to the people. Its efforts are being complemented by the acvtivities of the state-owned Water Corporations. These Corporations pump water with grid electricity where it is available and utilize diesel generators in the rural communities where grid electricity is unavailable. Only about 42% of the entire population have access to sate drinking water while 78% of the rural population do not have access to safe water [World Bank, 1994]. It is estimated that about 60% of the urban and 10% of the rural populations respectively have access to treated pipe-borne water [Federal Office of Statistics, 1994].

Results obtained from the analysis of water production and down time data from 14 diesel-generator-powered water pumping stations has earlier been reported (Oparaku, 1995). Due to the enormity of data, the calculations involved in the above analysis took a long time. To increase the speed of performing the analysis, a software has been developed. The features of the software and its capabilities are reported in this paper in addition to the water production and generator down time. The per capita water production for all the stations lies between 0.72 litres/day and 33.55 litres/day over the period (1984 – 1993). This is lower than the minimum specified by the WHO for developing countries. The low figures are due mainly to technical and social factors which include generator and sumo failures, fuel shortages, community disagreements, non-payment of bills etc.

SOFTWARE DESIGN AND DOCUMENTATION

The QuickBasic programming language was used in designing the software whose features and capabilities are enormous to ensure satisfactory analysis of water production and down time data collected from 16 water pumping stations over a period of ten years (1984-1993). In terms of scalability, it is designed to be flexible enough to accommodate future expansion in terms of the commissioning of more stations in future. Due to the necessity to move data (stored on monthly and yearly basis) in and out of the data file, a RANDOM access data file was used.

It has the flexibility required to sustain the pressure from both the software and hardware in the course of data movement. To accommodate both professional and non professional computer users, the software has been designed to be 90%

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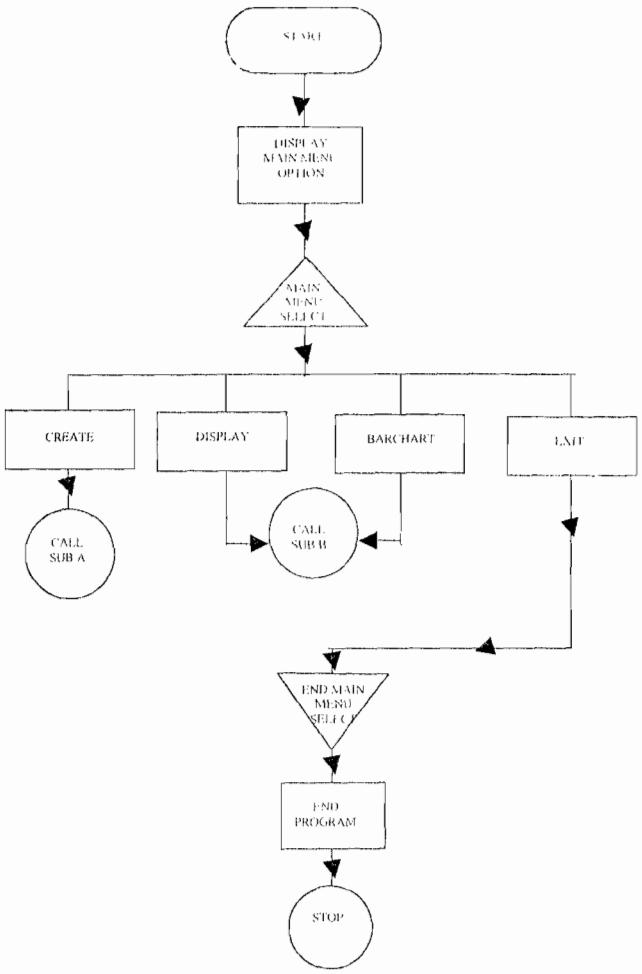

FIGURE 1: MAIN MENU FLOWCHART.

user – friendly and interactive. Its inter-modular interface and recursive capabilities make data entry and analysis very convenient.

FEATURES OF THE SOFTWARE

The software is about 95% menu –driven. The menu is divided into modules as shown in Figure 1. The EXIT option terminates the entire program.

The INPUT sub module (Figure 2), shows the sequence of data entry on station and yearly - month by month- basis. The raw values of water production and pump days as well as the types of faults (if any) are entered. The software calculates the down time values on monthly, yearly and period (10-year) basis as shown in Table 3. Similarly the per capita water production figures are calculated on yearly, seasonal (rainy and dry seasons) and periodic basis as shown in Table 2.

The Tabular Display Module (Figure 3) shows two types of values: the raw production values (in m^3), and the per capita values estimated by the software using the raw values. The raw values can be shown on monthly, yearly and periodic basis while the per capita values can be displayed on yearly, seasonal and periodic basis. Due to the number of stations and years involved, the software runs the display in batch mode. Hence, the yearly display shows a table of all the stations at a time under the various years in the period (1984 – 1993). The same applies to both raw and per capita values shown in Table 1. The down time values shown in Table 3 are also displayed in a similar manner.

For the graphical analysis/mode, bar charts are used to show the trends in production and per capita values. In this mode, the screen is divided into two. On the left hand side is displayed the total production of all the stations(Figure 5) over the period while on the right hand side, the yearly production of any chosen station can be displayed. For this option, a unique letter from the station's name is highlighted and pressing this letter on the keyboard automatically prompts the display of the production figures, year by year, on the right

TABLE 1

PER CAPITA PRODUCTION PER YEAR PER STATION										
STN	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
OBO	4.79	7.82	5.60	7.69	7.96	1.98	2.62	0.86	3.40	0.81
ETT	0.48	1.33	1.38	0.02	0.26	0.32	0.67	0.69	0.56	1.46
UMU	12.50	27.34	20.35	45.99	62.33	52.78	75.38	12.30	15.71	11.82
ONI	2.82	9.62	8.32	6.46	6.11	3.98	0.00	0.00	4.09	4.31
OPI	8.01	7.21	5.64	5.60	1.86	3.14	4.34	3.05	2.16	0.77
EHA	0.41	1.91	3.69	3.31	3.91	2.88	0.83	1.60	0.21	0.00
OVO	5.46	10.26	7.31	12.40	7.67	6.37	10.48	4.43	4.17	0.35
IKP	28.00	50.30	34.22	31.99	21.43	23.40	48.05	0.51	16.98	19.30
LEJ	2.41	4.15	3.59	4.24	3.69	3.12	2.21	2.41	2.02	2.45
OHO	4.16	4.90	4.03	4.33	4.32	3.74	4.61	3.49	6.31	2.51
ALO	4.46	12.41	5.49	1.04	3.47	2.98	3.85	1.92	2.51	3.90
UMA	2.23	9.68	9.63	9.21	4.63	5.28	13.39	9.43	6.61	7.61
AMA	7.49	8.53	9.45	8.96	9.26	9.81	27.52	15.37	6.31	8.13
IBA	1.26	3.86	4.58	4.23	2.73	2.17	1.39	0.32	0.73	2.37
AJI	0.00	8.34	4.32	0.58	0.41	0.31	0.56	0.30	0.90	0.16
UGB	2.16	8.87	9.03	7.37	7.95	4.34	2.71	2.54	4.95	3.44

TABLE 2

SUMMARY OF TOTAL PRODUCTION, PERIODIC PER CAPITA AND SEASONAL PER CAPITA

STATION	TOTAL PROD	DRYSN PROD	TOTAL P/CAP	DRYSN P/CAP	RAINY P/CAP	DRYP/TP X 100	AVG POP
OBOLLO-AFOR	355,353	208,019	4.35	6.06	3.47	58.54	23,225
ETTE	72,513	49,807	0.72	1.19	0.39	68.69	27,599
UMUAGAMA	1,075,462	684,434	33.55	42.45	25.28	63.64	4,833
ONITSHA-ENUGU	701,594	438,714	4.57	6.92	2.93	62.53	43,240
OPI	514,097	334,304	4.18	6.48	2.55	65.03	35,089
EHALUMONA	310,821	192,410	1.88	2.82	1.21	61.90	46,720
OVOKO	583,977	423,781	6.89	12.00	3.28	72.57	23,791
IKPAMODO	242,019	148,365	27.42	40.63	18.31	61.30	2,474
LEJJA	282,369	147,025	3.03	3.83	2.48	52.07	25,880
OHODO	347,438	250,461	4.24	7.39	2.02	72.09	22,514
ALOR-AGU	98,295	54,755	4.10	5.51	3.11	55.70	6,775
UMACHI	100,747	64,024	7.80	11.90	4.99	63.55	3,514
AMACHALLA	274,801	229,609	11.09	22.44	4.84	83.55	6,729
IBAGWA-ANI	158,140	71,869	2.36	2.65	2.18	45.45	18,820
AJI	54,531	32,667	1.59	2.27	1.11	59.91	10,048
UGBAIKE	124,087	74,832	5.34	7.72	3.65	60.31	6,488

TABLE 3

PERIODIC DOWNTIME PER STATION (FROM 1984 TO 1993)

STATION	PUMP DAYS	NO PUMP DAYS	FAULT DAYS	GEN SET FAULT	OTHER FAULT	GF/FD X 100	OF/FD X 100
OBOLLO-AFOR	1919	1369	757	336	421	44.39	55.61
ETTE	1372	1916	885	31	854	3.50	96.50
UMUAGAMA	1969	1319	202	90	112	44.55	55.45
ONITSHA-ENUGU	1966	1322	950	643	307	67.68	32.32
OPI	2075	1213	451	53	398	11.75	88.25
EHALUMONA	1622	1666	819	514	305	62.76	37.24
OVOKO	2007	1281	712	552	160	77.53	22.47
IKPAMODO	1814	1474	683	245	438	35.87	64.13
LEJJA	1719	1569	153	0	153	0.00	%100.00
OHODO	2047	1241	319	16	303	5.02	94.98
ALOR-AGU	1787	1501	610	213	427	33.28	66.72
UMACHI	1940	1348	245	0	245	0.00	%100.00
AMACHALLA	1845	1443	280	122	138	46.92	53.08
IBAGWA-ANI	1321	1967	971	61	910	6.28	93.72
AJI	1632	1656	881	0	884	0.00	%100.0
UGBAIKE	1683	1605	430	129	301	30.00	70.00

hand side of the screen.*

Similarly, for the yearly values displayed on the window on the left –hand side of the screen (Figure 4), a unique number from each year (1984 – 1993) is highlighted for selection against each year. Likewise, there is an instruction at the bottom line of the screen for the user to choose from the highlighted numbers (0 – 9) to see the monthly display on the window by the right – hand side of the screen.

RESULTS AND DISCUSSION

In Figure 4, a bar chart display of the yearly production figures of one of the stations – Obollo Afor- if presented on the left-hand side. The monthly production display on the right-hand side is prompted from the yearly display by selecting any of the highlighted numbers 0-9, each of which corresponds to a specific year.

The periodic production per station is shown in Figure 5. It is noted that Umuagama has the highest periodic production (in m^3) while Aji has the lowest .Again , it is possible to display – as shown on the right-hand side- the yearly production figures by selecting the highlighted letter (A – Z) assigned to that station. For Obollo-Afor, it is seen that 1991 and 1993 are the years with the lowest production.

The periodic per capita per station and the yearly per capita for any station are shown in Figure 6. It is seen that Umuagama which has the highest periodic production, also has the highest periodic per capita of 33.55 litres/day, while Aji, with the lowest periodic production, is not the station with the lowest per capita production. Rather, the station with the lowest per capita of 0.72 litres/day is Ette (Table 2). The reason is that the per capita figures are population dependent. Hence, Ette, with an average population of 27.599 and periodic production of

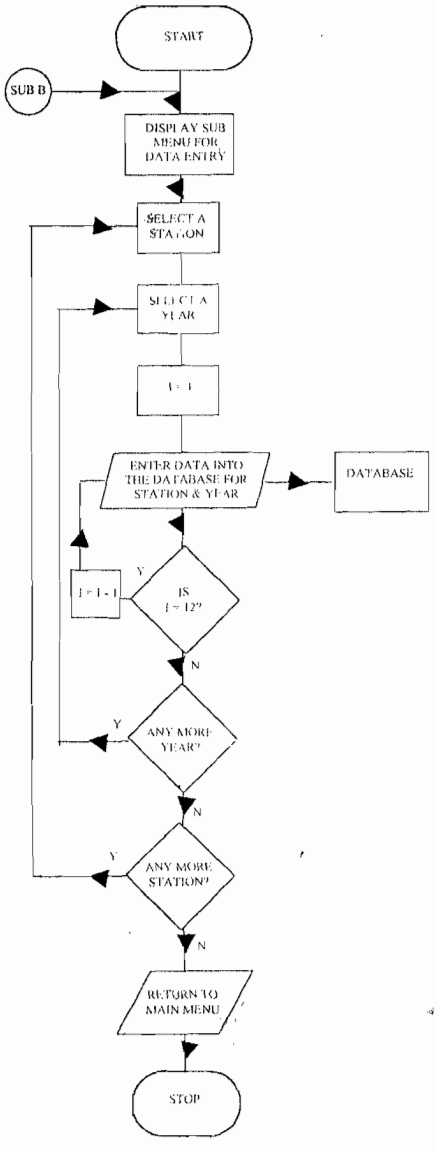

Figure 2: INPUT FLOWCHART

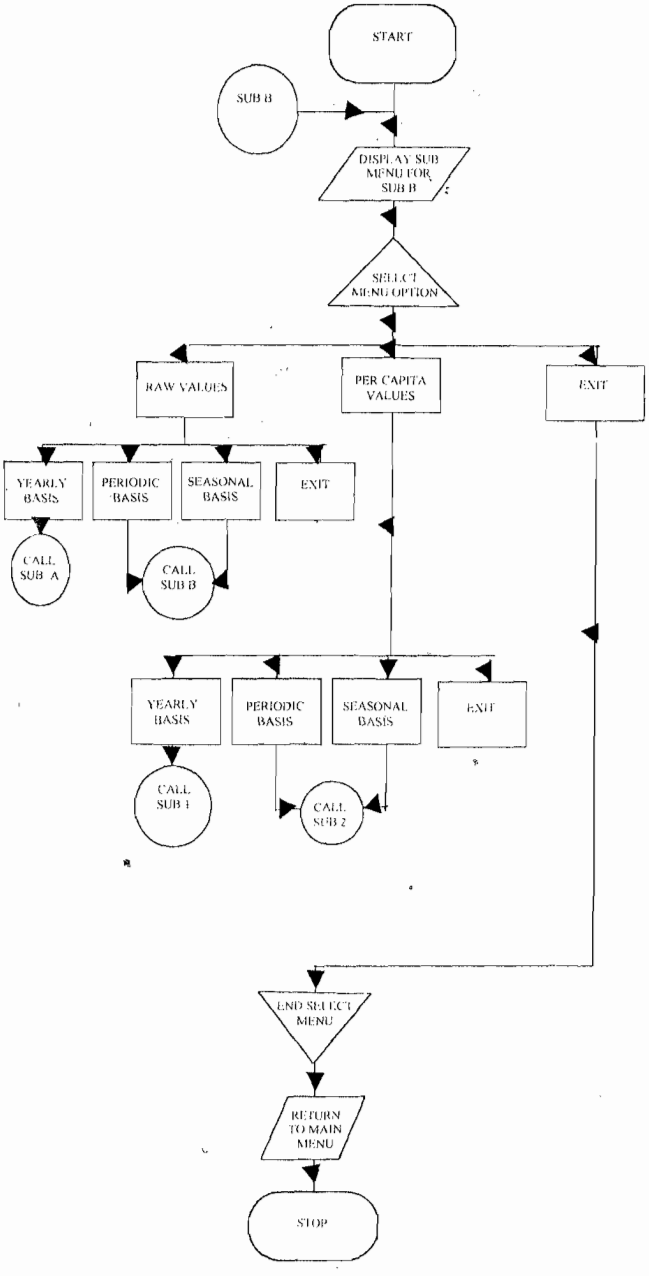

Figure 3: DISPLAY FLOWCHART

72,513 m^3 has a lower per capita than Aji (1.59 litres/day) which has a lower population of 10,048, though with a lower periodic production of 54,531. Umuagama and all the other stations with low population figures have higher per capita values. The yearly per capita figures for any station can be displayed as shown for Obollo-Afor on the right-hand side of Figure 6.

For each station, the per capita production for all the years can be displayed as shown in Table 1. From here, it is noted that the values fall below the minimum of 50 litres/day specified by the WHO for ensuring adequate sanitation and improved health of the populations in developing countries. The low figures are due mainly to technical and social factors which include diesel –generator and sumo breakdown, unavailability of fuel and engine oil, difficulties in obtaining spare parts promptly to effect repairs, community disagreements, non-payment of bills etc. We observe that onitsha- Enugu (4^{th} station) did not operate in 1990 and 1991.

A Summary of the periodic total and seasonal (rainy and dry season) per capita is presented in Table 2. The lowest and highest periodic per capita are 0.72 and 33.55 litres/ day for Ette and Umuagama respectively. The dry season per capita (DRYSN- P CAP) is consistently higher than the rainy season per capita (RAINY – P/CAP) for all the stations. This

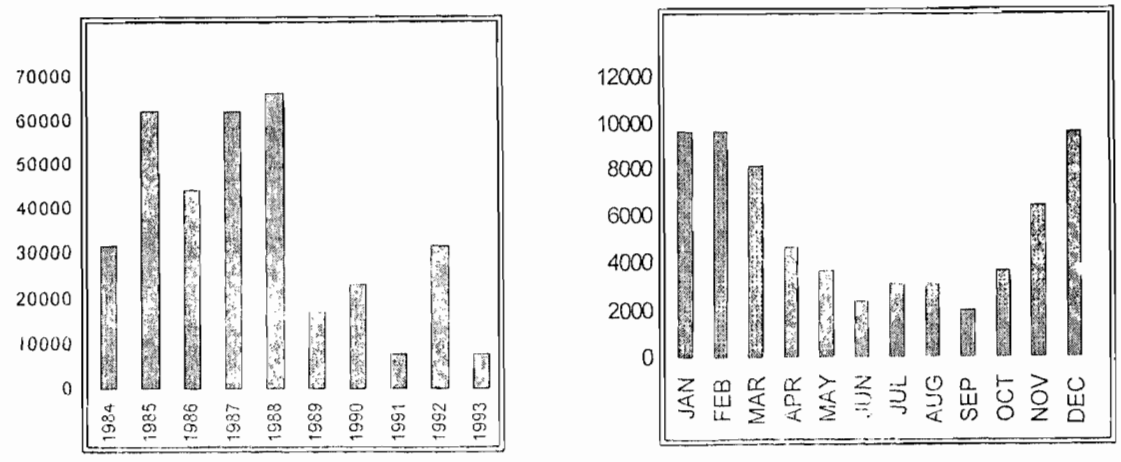

Figure 4: (a) Yearly Production Per Station and (b) Monthly Production for 1988.

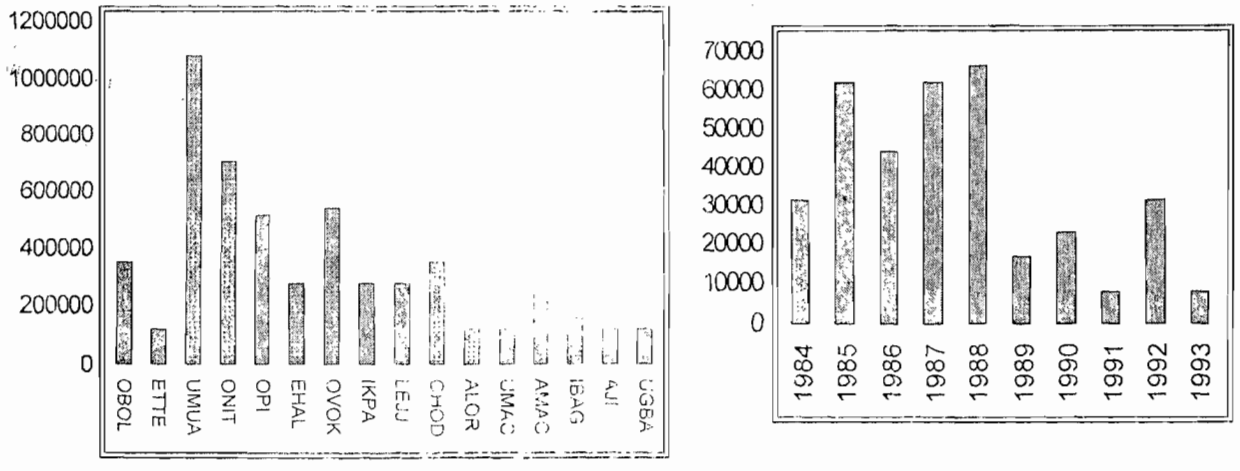

Figure 5: (a) Periodic Production Per Station (b) Yearly Production for Obollo-Afor.

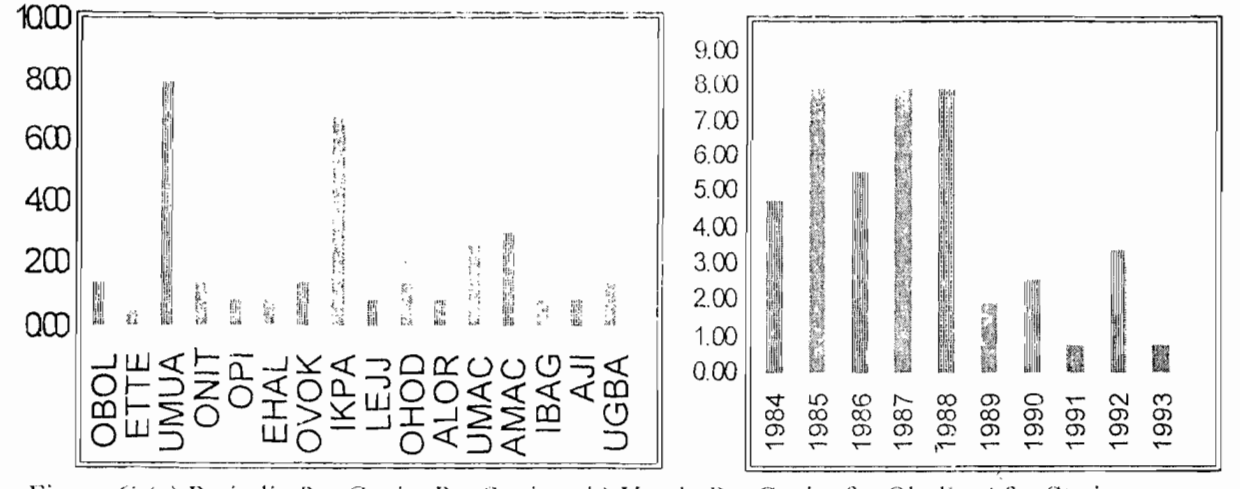

Figure 6: (a) Periodic Per Capita Per Station (b) Yearly Per Capita for Obollo-Afor Station.

is because the rural dwellers reduce their consumption of pumped water in the rainy seasons when they are able to collect rain water to supplement.

Table 3 shows the periodic down time for all the stations as obtained from the Fault Days (FD), Gen-set Fault (GF) days and other Faults (OF). The no-pump days include the days in which the system was idle, though without system fault. Lejja, Umachi and Aji did not experience any gen-set failure during the 10-year period. In terms of the percentage of the total fault days

(GF/FD), Ovoko, Ehalumona and Onitsha-Enugu had the highest generator failures. Other faults dominate the down time for other stations –as shown by the ratio OF /FD- particularly for Lejja, 'Umachi and Aji where there are no generator failures.

CONCLUSIONS

The software developed for the analysis of the water production and down time data for diesel-generator –operated pumping stations increases the speed and also enhances the analysis of data. It reduces the access time, run time and other time consuming factors inherent in the manual process. The low per capita water production figures are due mainly to down-time arising as a result of technical and social factors which include generator and sumo failures, non-availability of fuel and engine oil, community disagreements, non-payment of bills etc. In view of some of these factors, the state –owned Water Boards may have to consider other power supply options for pumping water. Solar-electric systems may be a viable alternative , particularly in rural areas where their adoption is most likely to be cost-effective.

ACKNOWLEDGEMENT

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APPENDIX

```
DECLARE SUB ben (s$, yr$, OPT$, y!(), pt!(), m%, n%)
DECLARE SUB pcys2 (y$)
DECLARE SUB disptotalseason ()
DECLARE SUB downyear ()
DECLARE SUB displaysummary ()
DECLARE SUB downtimemenu ()
DECLARE SUB yearlydowntime (yr$)
DECLARE SUB disptotaldowntime ()
DECLARE SUB yeardatabar (st$)
DECLARE SUB draydata ()
DECLARE SUB rainydata ()
DECLARE SUB seasonbardata ()
DECLARE SUB barmenu ()
DECLARE SUB pacapitabar ()
DECLARE SUB bargraph ()
DECLARE SUB STATIONp (op$)
DECLARE SUB yearp (ss$)
DECLARE SUB display ()
DECLARE SUB displayseason ()
DECLARE SUB pacapdisp ()
DECLARE SUB dispmenu ()
DECLARE SUB dispdry (s$)
DECLARE SUB disprainy (s$)
DECLARE SUB disppacapita (ss$, yy$, q%, r%, s%, t%)
DECLARE SUB rainypacap (s$)
DECLARE SUB drypacap (s$)
DECLARE SUB dispacap (s$)
DECLARE SUB chief (s$, yr$, year$(), y!(), pt!(),
                                          m%, n%)
DECLARE SUB pcys (s$)
DECLARE SUB pcps ()
DECLARE SUB displayyears (s$)
DECLARE SUB clearwin (r1%, c1%, r2%, c2%)
DECLARE SUB yeardata (st$)
DECLARE SUB WATERDATA (st$, yr$, opp$)
DECLARE SUB PACAPITA (ss$, yy$, q%, r%, s%, t%)
DECLARE SUB PRINTFILES (s$, y$)
DECLARE SUB stationbar ()
DECLARE SUB years (op$, r$)
DECLARE SUB windw (r1%, c1%, r2%, c2%)
DECLARE SUB ADDREC (s$, y$)
DECLARE SUB menu ()
DEFINT A-Z
CONST false = 0: true = NOT false
TYPE Recordtype
        station AS STRING * 15
        totgen  AS INTEGER
        tothers AS INTEGER
        genf AS INTEGER
        otherf AS INTEGER
        remarks AS STRING * 15
        DAYS AS INTEGER
        year AS STRING * 4
        water AS LONG
        twys AS SINGLE
        pop84 AS LONG
        drys AS LONG
        rainy AS LONG
        population AS LONG
        PACAPITA AS SINGLE
        drypacap AS SINGLE
        rainpacap AS SINGLE
        pdays AS INTEGER
        fdays AS INTEGER

        nopdays AS INTEGER
        drygenf AS INTEGER
        raingenf AS INTEGER

END TYPE
```

```
TYPE deltype
        station AS STRING * 15
        totgen  AS INTEGER
        tothers AS INTEGER
        genf AS INTEGER
        otherf AS INTEGER
        remarks AS STRING * 15
        DAYS AS INTEGER
        year AS STRING * 4
        water AS LONG
        twys AS SINGLE
        pop84 AS LONG
        drys AS LONG
        rainy AS LONG
        population AS LONG
        PACAPITA AS SINGLE
        drypacap AS SINGLE
        rainpacap AS SINGLE
        pdays AS INTEGER
        fdays AS INTEGER
        nopdays AS INTEGER
        drygenf AS INTEGER
        raingenf AS INTEGER

END TYPE


TDECLARE SUB ben (s$, yr$, OPT$, y!(), pt!(), m%, n%)
DECLARE SUB pcys2 (y$)
DECLARE SUB disptotalseason ()
DECLARE SUB downyear ()
DECLARE SUB displaysummary ()
DECLARE SUB downtimememenu ()
DECLARE SUB yearlydowntime (yr$)
DECLARE SUB disptotaldowntiDECLARE SUB ben (s$, yr$, OPT$, y!(), pt!(), m%, n%)
DECLARE SUB pcys2 (y$)
DECLARE SUB disptotalseason ()
DECLARE SUB downyear ()
DECLARE SUB displaysummary ()
DECLARE SUB downtimememenu ()
DECLARE SUB yearlydowntime (yr$)
DECLARE SUB disptotaldownti     TOTwater AS SINGLE
        station AS STRING * 15
        year AS STRING * 4
END TYPE
TYPE yeartype
        year AS STRING * 4
        YTOTAL AS SINGLE
        tot     AS LONG
        station AS STRING * 15
END TYPE
TYPE stationtype
station AS STRING * 15
statotal AS LONG
population AS INTEGER
PACAPITA AS LONG
END TYPE
DIM SHARED MONTHREC AS monthtype, s$(16), och4$(4)
DIM SHARED yearrec AS yeartype, dpach2$(3), dd$(4), dch$(5), dmch$(3), dpach$(4),
sch$(3), dch2$(3)
DIM SHARED starec AS stationtype, dele AS deltype
DIM SHARED pcpys(16), pcpyr&(16), PCPPS&(16), pop(16), och3$(6), pp&, t!(16),
y1&(16), YMIN&, y!(16)
DIM SHARED STVAL&(16), v1&(12), v11&(12), v12&(12), v13&(12), v14&(12),
total(12), op$(5), och$(4), ch$(4), mont$(12), year$(12), lab$(16), station$(17),
pt!(16)
DIM SHARED TOIL&(12), TDIS&(12), TDAYS&(12), THR&(12), MEN$(6), mt$(36), y1!(16)
DIM SHARED stationrec AS Recordtype
DIM SHARED reccount, MONTHRECCOUNT, yearreccount, stareccount, ymax!, t$, ye$(4),
yr$
DIM SHARED INDEX(1 TO 545) AS indextype, p84&(16)
OPEN "Energy.dat" FOR RANDOM AS #1 LEN = LEN(stationrec)
reccount = LOF(1) \ LEN(stationrec)
OPEN "delen.dat" FOR RANDOM AS #2 LEN = LEN(dele)
delcount = LOF(2) \ LEN(dele)
```

```
MEN$(1) = "WATER "
MEN$(2) = "OIL   "
MEN$(3) = "DIESEL"
MEN$(4) = "DAYS  "
MEN$(5) = "HOURS "
MEN$(6) = "EXIT  "

dch$(1) = "RAW VALUES        "
dch$(2) = "PACAPITA VALUES   "
dch$(3) = "DOWN TIME VALUES  "
dch$(4) = "EXIT              "

dd$(1) = "YEARLY DOWNTIME   "
dd$(2) = "PERIODIC DOWNTINE"
dd$(3) = "SEASONAL DOWNTINE"
dd$(4) = "EXIT              "

dch2$(1) = "RAW VALUES      "
dch2$(2) = "PACAPITA VALUES"
dch2$(3) = "EXIT            "

dmch$(1) = "YEARLY BASIS   "
dmch$(2) = "STATION BASIS "
dmch$(3) = "EXIT           "

dpach$(1) = "YEARLY BASIS     "
dpach$(2) = "SEASONAL BASIS   "
dpach$(3) = "PERIODIC SUMMARY"
dpach$(4) = "EXIT             "

dpach2$(1) = "YEARLY BAR   "
dpach2$(2) = "SEASONAL BAR"
dpach2$(3) = "EXIT         "

sch$(1) = "DRY SEASON   "
sch$(2) = "RAINY SEASON"
sch$(3) = "EXIT         "

mont$(1) = "JAN"
mont$(2) = "FEB"
mont$(3) = "MAR"
mont$(4) = "APR"
mont$(5) = "MAY"

mont$(6) = "JUN"
mont$(7) = "JUL"
mont$(8) = "AUG"
mont$(9) = "SEP"
mont$(10) = "OCT"
mont$(11) = "NOV"
mont$(12) = "DEC"
station$(1) = " OBOLLO-AFOR    "
station$(2) = " ETTE           "
station$(3) = " UMUAGAMA       "
station$(4) = " ONITSHA-ENUGU "
station$(5) = " OPI            "
station$(6) = " EHALUMONA      "
station$(7) = " OVOKO          "
station$(8) = " IKPAMODO       "
station$(9) = " LEJJA          "
station$(10) = " OHODO          "
station$(11) = " ALOR-AGU       "
station$(12) = " UMACHI         "
station$(13) = " AMACHALA       "
station$(14) = " IBEAGWA_ANI    "
station$(15) = " AJI            "
station$(16) = " UGBAIKE        "
station$(17) = " EXIT           "
op$(1) = "CREATE       "
op$(2) = "UPDATE       "
op$(3) = "DISPLAY      "
op$(4) = "BAR CHART    "
op$(5) = "EXIT         "

mt$(1) = "J"
mt$(2) = "A"
mt$(3) = "N"
mt$(4) = "F"
mt$(5) = "E"
mt$(6) = "B"
mt$(7) = "M"
mt$(8) = "A"
mt$(9) = "R"
mt$(10) = "A"
mt$(11) = "P"
mt$(12) = "R"
mt$(13) = "M"
mt$(14) = "A"
mt$(15) = "Y"
mt$(16) = "J"
mt$(17) = "U"
mt$(18) = "N"
mt$(19) = "J"
mt$(20) = "U"
mt$(21) = "L"
mt$(22) = "A"
mt$(23) = "U"
mt$(24) = "G"
mt$(25) = "S"
mt$(26) = "E"
mt$(27) = "P"
mt$(28) = "O"
mt$(29) = "C"
mt$(30) = "T"
mt$(31) = "N"
mt$(32) = "O"
mt$(33) = "V"
mt$(34) = "D"
mt$(35) = "E"
mt$(36) = "C"

ch$(1) = "MONTHLY BAR "
ch$(2) = "YEARLY BAR  "
ch$(3) = "PACAPITA BAR"
ch$(4) = "EXIT        "
och$(1) = "MONTHLY "
och$(2) = "YEARLY  "
och$(3) = "PACAPITA"
och$(4) = "EXIT    "

och3$(1) = "PACAPITA PER YEAR      "
och3$(2) = "PACAPITA PER STATION   "
och3$(3) = "DRY SEASON PACAPITA    "
och3$(4) = "RAINNY SEASON PACAPITA"
och3$(5) = "EXIT                   "

och4$(1) = "PACAPITA PER STATION PER YEAR"
och4$(2) = "DRY SEASON PACAPITA          "
och4$(3) = "RAINNY SEASON PACAPITA       "
och4$(4) = "EXIT                         "

year$(1) = "1984"
year$(2) = "1985"
year$(3) = "1986"
year$(4) = "1987"
year$(5) = "1988"
year$(6) = "1989"
year$(7) = "1990"
year$(8) = "1991"
year$(9) = "1992"
year$(10) = "1993"
year$(11) = "EXIT"

'FOR n = 1 TO reccount
        'GET #1, n, stationrec
        'INDEX(n).recno = n
        'INDEX(n).station = stationrec.station
        'INDEX(n).water = stationrec.water
        'INDEX(n).year = stationrec.year
        'INDEX(n).population = stationrec.population
        'INDEX(n).drys = stationrec.drys
       ' INDEX(n).rainy = stationrec.rainy

'NEXT n
'CALL main
CLS
CALL menu
CLOSE
END

SUB ADDREC (s$, v$)
```

```
CLOSE #1
OPEN "Energy.dat" FOR RANDOM AS #1 LEN = LEN(stationrec)
reccount = LOF(1) \ LEN(stationrec)
pp& = 0
CLS
FOR i = 1 TO reccount
        GET #1, i, stationrec

        IF (LTRIM$(RTRIM$(stationrec.station)) = RTRIM$(LTRIM$(s$))) AND
(RTRIM$(LTRIM$(stationrec.year)) = RTRIM$(LTRIM$(y$))) THEN
                BEEP: BEEP
                LOCATE 23, 2
                PRINT "Year already created!!...press any key"
                SLEEP
                COLOR 15, 1
                CLS
                EXIT SUB
        ELSEIF y$ = "1984" THEN

                        INPUT "Enter population figure for 1984 (ONLY)"; pp&
                        GOTO ex
        END IF
NEXT i
IF reccount = 0 THEN
        IF y$ = "1984" THEN
                INPUT "Enter population figure for 1984 (ONLY)"; pp&
                GOTO ex
        END IF
END IF
ex:

CLS
COLOR 15, 4
windw 1, 1, 19, 79
LOCATE 2, 10: PRINT "DATA ENTRY", "FOR"; s$; "STATION  FOR "; y$
LOCATE 4, 10
LOCATE 4, 10: PRINT "WATER"
LOCATE 4, 25: PRINT " DAYS": LOCATE 4, 35: PRINT "REMARKS"
LOCATE 5, 10
PRINT STRING$(57, "=")

FOR i = 1 TO 12
        LOCATE i + 5, 2
        PRINT mont$(i)
NEXT i
rc = reccount
nfd& = 0: npd& = 0: pd& = 0: odt& = 0: gdt& = 0: fd& = 0: dry& = 0: rain& = 0
FOR i = 1 TO 12
r4:                 LOCATE i + 5, 10: INPUT " ", a$
                vle& = VAL(a$)
                IF vle& < 0 THEN
                        BEEP
                        BEEP
                        LOCATE i + 5, 10: PRINT " Please Enter A Positive
Integer...press any key"
                        SLEEP
                        LOCATE i + 5, 10: PRINT SPACE$(55)
                        GOTO r4
                END IF
                lt = LEN(a$)
                a& = VAL(a$)
                IF lt > 5 THEN
yl:                     BEEP
                        BEEP
                        LOCATE i + 5, 10: PRINT " Please Enter Correct values(5
digits)...press any key"
                        SLEEP
                        LOCATE i + 5, 10: PRINT SPACE$(55)
                        GOTO r4
                  END IF
                        vl&(i) = a&

                IF i = 1 OR i = 2 OR i = 3 OR i = 11 OR i = 12 THEN
                        rt$ = "d"
                        dry& = dry& + a&
                ELSE
                        rt$ = "r"
                        rain& = rain& + a&
                END IF
r5:             LOCATE i + 5, 25: INPUT " ", DT$
                vle& = VAL(DT$)
                IF vle& < 0 THEN
```

```
                        BEEP
                        BEEP
                        LOCATE i + 5, 23: PRINT " Please Enter A Positive
Integer...press any key"
                        SLEEP
                        LOCATE i + 5, 23: PRINT SPACE$(55)
                        GOTO r5
                END IF

                lt = LEN(DT$)
                DT& = VAL(DT$)
                IF lt > 2 THEN
                        BEEP
                        BEEP
                        LOCATE i + 5, 25: PRINT " Please Enter Correct values(2
digits)...press any key"
                        SLEEP
                        LOCATE i + 5, 25: PRINT SPACE$(54)
                        GOTO r5
                  END IF
                IF DT& > 31 THEN
                        BEEP
                        BEEP
                        LOCATE i + 5, 25: PRINT "Values MUST not be greater than
31...press any key"
                        SLEEP
                        LOCATE i + 5, 25: PRINT SPACE$(54)
                        GOTO r5
                  END IF

R6:             LOCATE i + 5, 35: INPUT " ", rm$

                IF i = 4 OR i = 6 OR i = 9 OR i = 11 THEN
                        nod = 30
                ELSEIF i = 2 THEN
                        yr& = VAL(y$)
                        IF yr& MOD 4 = 0 THEN
                                nod = 29
                        ELSE
                                nod = 28
                        END IF
                ELSE
                        nod = 31
                END IF
                fd& = nod - DT&
                IF rm$ = "g" OR rm$ = "G" THEN
                        rm$ = "GEN FAULT"
                        od& = 0
                        IF rt$ = "d" THEN
                        dgf& = dgf& + fd&
                        ELSEIF rt$ = "r" THEN
                        rgf& = rgf& + fd&
                        END IF
                         gd& = fd&
                         gdt& = gdt& + fd&
                ELSEIF rm$ = "o" OR rm$ = "O" THEN
                         rm$ = "OTHER FAULTS"
                         gd& = 0
                         od& = fd&
                         odt& = odt& + fd&
                ELSEIF rm$ <> "" THEN
                         BEEP: BEEP
                         LOCATE i + 5, 30
                         PRINT "Enter correct STRING!!...press any key"
                         SLEEP
                         LOCATE i + 5, 30: PRINT SPACE$(48)
                         GOTO R6
                END IF
                LOCATE 23, 10
                PRINT "Are Data Okay!!..Y/N";
                INPUT res$
                COLOR 15, 1
                LOCATE 23, 10
                PRINT SPACE$(28)
                COLOR 15, 4
                IF res$ = "" GOTO r4
                IF res$ = "y" OR res$ = "Y" THEN 91
                IF res$ = "n" OR res$ = "N" GOTO r4
91 :
                tt! = tt! + ba&
                IF year$(i) = y$ THEN n = i
                IF ba& = 0 THEN
                        npd& = npd& + nod
```

```
                    ELSE
                            pd& = pd& + DT&
                    END IF
                    IF ba& <> 0 THEN npd& = npd& + fd&
                    stationrec.water = ba&
                    stationrec.station = s$
                    stationrec.year = y$
                    stationrec.genf = gd&
                    stationrec.otherf = od&
                    stationrec.remarks = rm$
                    reccount = reccount + 1
                    PUT #1, reccount, stationrec
tp:
NEXT i
nfd& = odt& + gdt&
IF n = 1 GOTO xx
GET #1, reccount, stationrec
pp& = stationrec.pop84
pop! = pp& * (1.029) ^ (n - 1)
stationrec.population = pop!
GOTO xx2
xx:
stationrec.pop84 = pp&
stationrec.population = pp&
pop! = pp&
xx2:
pcs! = tt! * 1000 / (365 * pop!)
pds! = dry& * 1000 / (151 * pop!)
prs! = rain& * 1000 / (214 * pop!)
pcs! = pcs! * 100
pds! = pds! * 100
prs! = prs! * 100
pc = CINT(pcs!)

pc2 = CINT(pds!)
pc3 = CINT(prs!)
c! = pc / 100
c2! = pc2 / 100
c3! = pc3 / 100
stationrec.totgen = gdt&
stationrec.tothers = odt&
stationrec.pdays = pd&
stationrec.nopdays = npd&
stationrec.drygenf = dgf&
stationrec.raingenf = rgf&
stationrec.fdays = nfd&
stationrec.rainy = rain&
stationrec.drys = dry&
stationrec.twys = tt!

stationrec.PACAPITA = c!
stationrec.drypacap = c2!
stationrec.rainpacap = c3!
PUT #1, reccount, stationrec
pp& = 0
pop! = 0!
LOCATE 20, 4: PRINT "TOTAL "; tt!; TOTAL1#; TOTAL2#; TOTAL3#; TOTAL4#;
SLEEP
COLOR 15, 0
END SUB

SUB bargraph
DO
sel = 1
LST = 1
W = 25
CALL clearwin(4, 20, 8, 38)
COLOR 15, 1
q = 4: r = 20: s = 8: t = 38
CALL windw(q, r, s, t)
FOR i = 1 TO 3
        LOCATE i + q, r + 1
        PRINT " "; dch2$(i)
NEXT i
DO
COLOR 15, 1
LOCATE LST + q, r + 1
PRINT " "; dch2$(LST)
COLOR 15, 4
LOCATE sel + q, r + 1
```

```
LOCATE sel + q, r + 1
PRINT CHR$(W)
LST = sel
DO
   pnt$ = INKEY$
LOOP WHILE pnt$ = ""
COLOR 15, 1
SELECT CASE pnt$
        CASE CHR$(27)
                COLOR 15, 0
                EXIT SUB
                'CALL menu
        CASE CHR$(0) + CHR$(72)
        IF sel = 1 THEN
                        sel = 3


          ELSE
                         sel = sel - 1

           END IF
                W = 24
         CASE CHR$(0) + CHR$(80)
                IF sel = 3 THEN
                         sel = 1
                ELSE
                         sel = sel + 1
                END IF
               W = 25
        CASE CHR$(13)
             SELECT CASE sel
                CASE 1
                        barmenu
                        EXIT DO
                  CASE 2
                        pacapitabar
                        EXIT DO
                CASE 3
                        COLOR 15, 0
                        CALL clearwin(4, 20, 8, 38)
                        COLOR 15, 0
                        EXIT SUB
                        'CALL menu
                        END SELECT
END SELECT
'EXIT DO
LOOP
LOOP
 COLOR 15, 0
' CALL menu


END SUB

SUB barmenu
DO
sel = 1
LST = 1
W = 25
CALL clearwin(4, 53, 22, 76)
q = 4: r = 41: s = 8: t = 58
COLOR 15, 1
CALL windw(q, r, s, t)
FOR i = 1 TO 3
        LOCATE i + q, r + 1
        PRINT " "; dmch$(i)
NEXT i
DO
COLOR 15, 1
LOCATE LST + q, r + 1
PRINT " "; dmch$(LST)
COLOR 15, 4
LOCATE sel + q, r + 1
PRINT " "; dmch$(sel)
COLOR 23, 1
LOCATE sel + q, r + 1
PRINT CHR$(W)
LST = sel
DO
   pnt$ = INKEY$
```