NOAA Technical Memorandum NWS WR-192

NWR VOICE SYNTHESIS PROJECT: PHASE I

Salt Lake City, Utah
January 1986

U.S. DEPARTMENT OF COMMERCE / National Oceanic and Atmospheric Administration / National Weather Service

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ESSA Technical Memoranda, Weather Bureau Technical Memoranda (WBTM)

25 Verification of Operational Probability of Precipitation Forecasts, April 1966-March 1967. W. W. Dickey, October 1967. (PB-176240)
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109 Forecasting North Winds in the Upper Sacramento Valley and Adjoining Forests. Christopher E. Fontana, September 1976. (PB-273-677/AS)
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119 Relative Frequency of Occurrence of Warm Season Echo Activity as a Function of Stability Indices Computed from the Yucca Flat, Nevada, Rawinsonde. Darryl Randerson, June 1977. (PB-271-290/AS)

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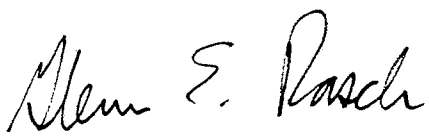

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I. INTRODUCTION

Voice synthesis technology within the last few years has made tremendous leaps and bounds in reducing the costs, and increasing the quality and capabilities of end user oriented systems. Descriptions of these new systems can be conveniently divided into two categories: text-to-voice speech (also known as synthetic speech), and phrase concatenation speech (where words and phrases are linked together to form the speech).

Synthetic speech is obviously the most useful and versatile form of the current voice synthesis technology, since any text message can be spoken regardless of format or content. A person needs only to type in what is to be spoken, and the voice system will speak it. The drawbacks to this type of system are a lower speech quality, and a relatively high mispronounciation rate of names and geographical locations (about 20%). These systems are frequently described as having a heavy "Swedish" accent.

Phrase concatenation technology on the other hand uses prerecorded words and/or phrases to produce the speech. This type of voice system has a predefined vocabulary and thus restricts the type of messages which can be spoken. Speech quality is very realistic and human sounding, with the automation aspect only apparent if the phrases or words do not link together smoothly.

Generally when people think of prerecorded phrases in the phrase concatenation technology, they think of this system being similar to a tape recorder. This idea is not true. A tape recorder records sound waves in an analog format; a voice synthesis system records speech in a digital format. Only when the voice data is in a digital format can it be efficiently controlled and manipulated by a computer.

In examining the products currently available on the market, the decision was made that synthetic voice technology does not have the high quality speech required for broadcast over NOAA Weather Radio (NWR). Therefore the system presented in this paper uses the phrase concatention type of technology for a very high quality, versatile, voice synthesis system.

II. CAPABILITIES OF THE SYSTEM

A. Purpose of this Voice Synthesis Project

The purpose of the NWR Voice Synthesis Project is to provide a demonstration of the current voice synthesis technology. Phase I of this project is presented in this paper, and provides a complete automation of an hourly surface aviation observation for broadcast over NWR. Phase I does not include any functions other than the automation of one surface observation for one NWR console.

Future phases of this project will provide automation or semi- automation of other set format products (e.g. hourly roundups or zone forecasts). Additionally a voice override feature is planned to encompass products difficult to decode. This override feature will allow the voice synthesis system to reject an inconsistent product and ask for manual voice input.

B. How It Works

The first task in assembling a system of this type is defining the phrases or words you need in the vocabulary. The phrase concatenation voice system selected for this project provides the capabilities to both record and speak digital voice data from disk. Thus once the vocabulary is defined, a simple utility program can record your data onto the disk for future use.

The technically difficult portion now becomes writing the software to decode the raw observation data, assemble a voice product and maintain the product broadcast on NWR. Figure 1 presents the data flow on this voice synthesis system. Data is initially received from the NWS Automation of Field Operations and Services (AFOS) communication system into an IBM PC/XT. The IBM then decodes the data, encodes a voice product and maintains the product broadcast through an existing NWR console. The signals from one tape deck are interfaced to the IBM allowing the IBM to simulate and essentially replace a tape deck in the NWR console.

Figure 1 further depicts the main software modules running on the IBM PC/XT. Functional descriptions of each module are:

1. Communication routine. The communication module receives the input data from AFOS and stores these data into a circular memory buffer. Once a product is completely received, a flag is set alerting the observation decoder that a new product is ready for decoding.

2. Observation decoder routine. When a new product is received this module retrieves the product from the communication routine input buffer, and simultaneously decodes and encodes a voice product. After the observation is completely decoded, a program array containing the voice product phrases is updated for use by the broadcast routine.

3. Broadcast routine. The NWR console alerts this routine to start the observation broadcast. The proper phrases from the program array are read from the disk into memory, and spoken. Once the broadcast is finished, a start signal is transmitted to the next tape deck in the console cycle sequence.

All three of these modules are running simultaneously on the IBM to ensure no loss of data or missed broadcast sequences.

C. System Limitations

Phase I of the NWR Voice Synthesis Project in itself is a complete package, and has no limitations for decoding a single surface observation if the data is coded properly. If the data is coded wrong, the observation decoder will attempt to assemble a reasonable voice product or toss the entire observation.

Looking at this voice system as a whole and not just Phase I of this project, a number of limitations do exist in the system. The amount of vocabulary this system can maintain is limited by the amount of available disk space. Ten megabytes of disk space translates to about 40 minutes of speech. Phase I uses about 0.8 megabytes of disk space, so while this is a limitation it is not severe and can be easily overcome by increasing the disk size.

Another limitation common in all computers is the amount of available memory. An IBM PC is capable of having 640K maximum addressable memory. The features of this voice system do/could use the following amounts of memory:

observation decoder	10K
broadcast routine	129K
user menu for interaction	10K
recording routine (100 sec.)	401K
TOTAL	550K

The Phase I software uses a slim 139K. Additional capabilities useful on the system bring the total to 550K. This leaves 90K for developing further product decoding routines. Overall the system limitations are not detrimental to expanded use in the NOAA Weather Radio program, or most other related applications.

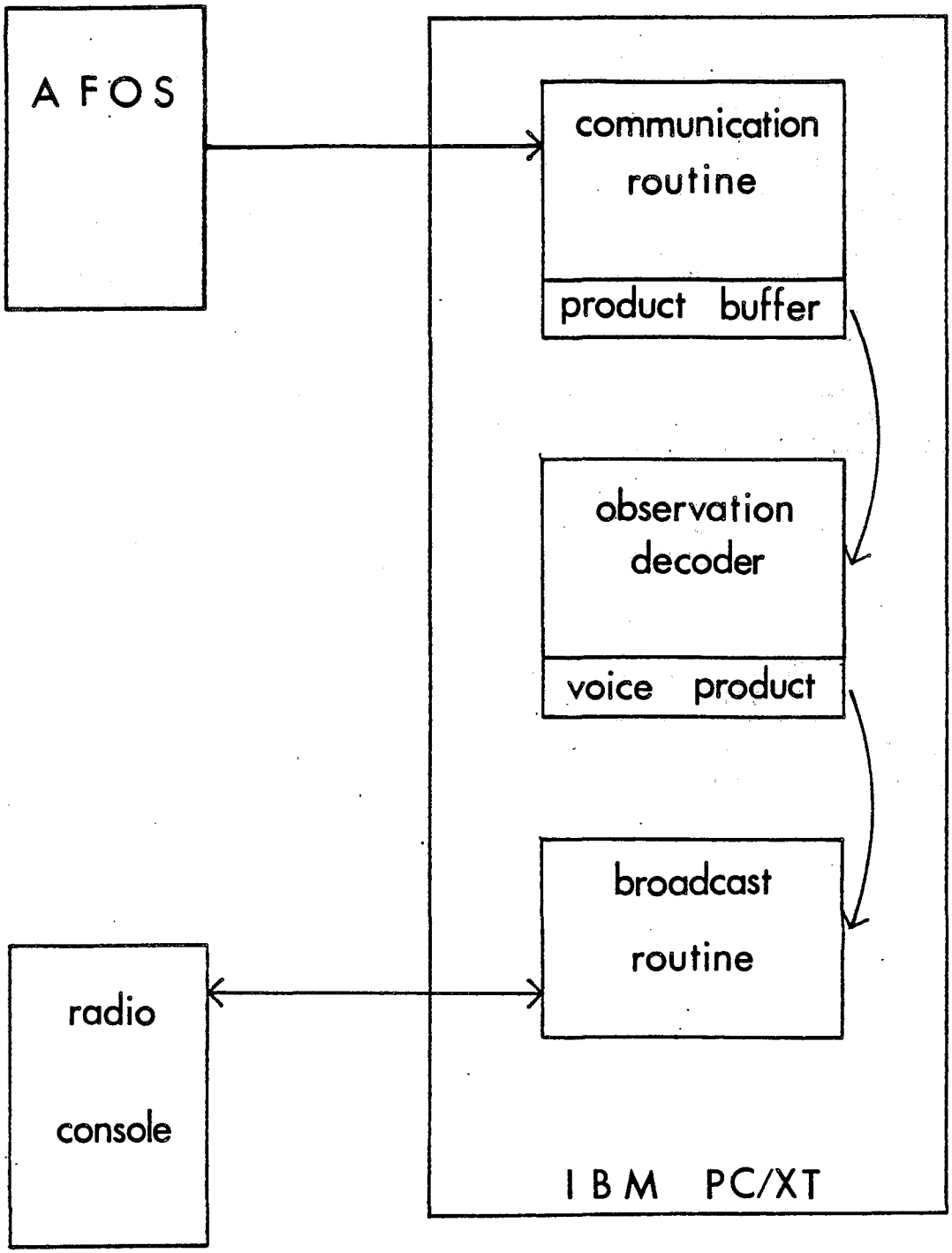

Figure 1 - Diagram depicts the data flow on the voice synthesis system, and the software modules running on the IBM.

III. SYSTEM ARCHITECTURE

A. Hardware Components

All the hardware used in this voice synthesis system consists of off-the-shelf products. The components are: a standard IBM PC/XT with monochrome monitor and keyboard, AST Six Pak Plus memory expansion, and a Vynet V101I/SD/SP voice synthesis board. The total cost of a system is approximately $6000.

Accessories necessary for system development and helpful in general use are: a tape deck for recording your phrase speaker, a microphone, and an audio speaker. These items have a total cost of about $300.

B. Software Design

A brief overview of the software design was presented in Figure 1 and Section IIB (How It Works). This design is closely associated with the IBM system architecture to allow a simulated multi-tasking environment. The communication routine and the broadcast routine are interrupt driven to allow the most efficient use of the system resources. Since interrupts are utilized, the operating system can remain MS-DOS which is the standard for the IBM PC. If interrupts were not utilized, the timing relationships between software modules could become a problem as the system develops. Furthermore no multi-tasking operating system for the IBM PC is currently a standard, so the software design reflects these facts.

All crucial real-time software modules (the communication and broadcast routines) are device driver level code. The decoder routine is a poll oriented routine and thus does not interfere with the real-time functions.

The communication routine handles an interrupt upon receipt of a character and puts this character into a memory buffer. When the product is completely received, a flag is set containing the location of the start of the product in the buffer. This design of the communications isolates the receipt of data from the rest of the system with the only inter-task communication conducted via the memory buffer and the product receipt flag.

The broadcast routine is very similar in design to the communication routine. The NWR console provides a signal to an asynchronous communication adapter to generate the "start of broadcast" interrupt. This interrupt triggers a transmit routine for speaking the voice product and providing a "start next tape" signal back to the NWR console when finished. After broadcast completion the regular polled routines running on the IBM are resumed. The only inter-task communication is conducted via the program array containing the voice product phrases. Future developments in this system will allow execution of the polled routines during the broadcast periods.

The surface observation decoder is triggered when the product receipt flag is set. A monitoring routine continually polls this flag until data is present. Once data is present, a check is done to determine the type

of data for starting the proper decoding/encoding function. Currently only a surface observation decoder is present, but other decoders can simply be added by writing the decoding/encoding function and including an entry in the monitoring routine.

Software maintenance and expansion of the system is relatively easy because the static functions (the communication and broadcast routines) are separated from the more dynamically oriented polled routines. Once this system is fully developed, changes should only need to occur in the polled routines. Furthermore the device drivers are the more technically difficult and hardest to change of the software routines, since they are written in assembly language. The polled routines, on the other hand, are written in a higher level language (i.e. C) enabling easier changes and access.

Additional details on the software can be found in section V (Software Documentation).

IV. USERS' GUIDE

The voice synthesis system is a prototype system and has been designed so that a user can easily determine if the system is operating properly. Three "windows" have been given the user to allow system monitoring. These "windows" are:

1. All data coming into the system are echoed on the screen with the header "Product is:". This "window" allows the user to determine if the communication task and decoder routine are working properly.

efore transmitting a product, the message appears "now transmitting" on the screen. When the broadcast is done the message appears "done transmitting". These messages allow the user to determine if the broadcast routine is working properly. Additionally the user can turn on a NWR receiver when the "now transmitting" message appears to hear the broadcast.

3. When the system is neither decoding a product nor broadcasting a product the keyboard is functional. If the user hits any keyboard key a character will be echoed to the screen. This last window insures the product receipt monitor and decoder routines are running.

If any of these "windows" fails to work the system is down and startup procedures need to be executed.

A. System Startup Procedures

The system is extremely easy to start, and can be done by two methods:

1. If the power is off, turn the power on. A red toggle power switch is located on the right rear side of the CPU box.

2. If the power is already on enter \AUTOEXEC and the system will come up.

When the system has come up properly, a "System up" message will be displayed.

B. System Shutdown Procedures

System shutdown can be done by two methods depending on the circumstances:

1. If the system appears to be working properly, simultaneously type the CTRL and C keys to get a "System down" message.

2. If the "windows" indicate a system crash, turn the power off.

C. If Disaster Strikes

Since this voice synthesis system is of a prototype nature, the possibility exists for the system not to work properly. If this occurs and you can not get the system up, turn the IBM PC/XT power switch off then remove the IBM from the radio console sequencer.

D. Error Messages

When the system is being started, an initialization process occurs before the "System up" message appears. Errors can be encountered during this initialization which will abort the system from coming up. Before aborting, an error message will be displayed providing enough details for interpretation by a person familiar with the system.

Other less serious errors can occur in the surface observation decoding routine. These errors display the message "observation not decoded #", where # is a code for the type of error. These codes are:

1	observation not an SA or RS
2	invalid/old observation time
3	bad wx phenomena (freezing ?)
4	bad wx phenomena (ice ?)
5	bad wx phenomena (blowing ?)
6	bad wx phenomena (ground ?)
7	unknown wx phenomena
8	bad visibility (sixteenths)
9	bad visibility (eigths)
10	visibility coded improperly
11	wind coded improperly
12	air temperature beyond limits
13	dewpoint beyond limits

If these errors occur the correction (COR) observation, which should be issued, will correct the problem and properly update the voice product.

V. SOFTWARE DOCUMENTATION

A. Radiol.c

Radiol is the main program used to generate the voice product for broadcast over the NWR console. This program initializes the system and contains monitoring routines for decoding products and processing keyboard input. The following functions are contained in this file:

main	loadidx	saodec	extend
intensity	ltg	fill	missing
templd	rh	vpbelo	vpabov
alpha	parse	unparse	loadpgm
fatal	strgmv	inc	dec

Radiol uses "include" files which contain the parameter definitions, external variable declarations and the Lattice default paramters. These files are: define.c, extern.c, stdio.h and ctype.h.

```
/*      date:  May 1985
        version:  1.0
        by:  Glen W. Sampson, NWS WRH DATAC

Purpose:
  This program is designed to automate the hourly surface aviation
observation for NOAA Weather Radio.  Data is received directly from
AFOS, decoded and encoded into a voice product and broadcast through
the NWR console.

Exits:
  Errors can halt the execution of this program during the initializa-
tion phase.  These error messages fit into the following categories:
        1.  unable to open a file;
        2.  unable to read from a file;
        3.  and, device drivers or proper hardware not installed.
Once the program is running, no fatal errors should occur.

Created by:
  (Version 2.14 of Lattice C, Version 2.10 of Link)
        C>lc1 radio1 -mD
        C>lc2 radio1 -v
        C>link cd radio1 mface func transmit, radio1, nul, lcmd lcd
*/
#include "define.c"                 /* get the #define parameters */
#include "extern.c"                 /* ...and the extern types */
#include "stdio.h"                  /* ...and the standard I/O file */
#include "ctype.h"                  /* char manipulations */

main()
{
/*  define the variables  */
char s[20];                         /* general purpose string variable */
char c;                             /* general purpose char variable */
char inc(), dec(), getchr();        /* functions returning chars */
char *getml();                      /* function returning a pointer */
int fdsao;                          /* sao voice data file descriptor */
int fd;                             /* general file descriptor */
int status;                         /* Vynet status retrieval word */
int i, j;                           /* general purpose counter */

/*  initialize Vynet hardware/software */
        if (ChkDrv() != 0) {
                printf("Vynet driver is not installed\n");
                exit();
        }
        if ((status = Init(0)) == NO_HARDWARE) {
                printf("unable to initialize hardware\n");
                exit();
        }

/*  catalog voice index files  */
        if ((fdsao = Dopen (0, "sao_vd.idx")) == ERROR)
                fatal ("unable to open SAO_VD.IDX\n");

        /* read in the data (trim the phrase number) */
        if (loadidx (&obs[0].sa_high, saophr, fdsao))
```

```
                fatal ("unable to read SAO_VD.IDX\n");
        Dclose (fdsao);                         /* close file */

        /* open the actual voice data file */
        if ((fdsao = Dopen(0, "sao_vd.phs")) == ERROR)
                fatal ("unable to open SAO_VD.PHS\n");

/*  initialize voice data buffers  */
        ptr1 = getml(655361);                           /* buf #1 */
        ptr2 = getml(655361);                           /* buf #2 (64K) */

        /* put headers in the data buffers */
        for (i = 0; i < 7; i++) {
                ptr1[i] = header[i];
                ptr2[i] = header[i];
        }

/*  restore the previous program  */
        if ((fd = Dopen(0, "pgmfile")) == ERROR)
                fatal("unable to open PGMFILE\n");
        if (Dread(fd, (unsigned) (pgmphr+1) * 8, &pgm[0]) == ERROR)
                fatal("unable to read PGMFILE\n");
        for (i = 0; pgm[i].pg_fd != -1; i++);           /* find pgm end */
        oldalt = pgm[i].pg_high;                        /* restore past alt */
        minmax = pgm[i].pg_low;                         /* restore min/max */
        Dclose(fd);                                     /* close file */

/*  initialize comms port(s) and enable interrupts  */
        setcom(0,131);                                  /* setup the comms ports */
        setcom(1,131);
        setread(&buf[0],&buf[maxbuf]);                  /* enable interrupts */
        setstat();                                      /* int to NWR con */
        prodflg = 0;                                    /* init flags */
        for (i = 0; i < 25; i++)
                printf("\n");
        printf("System up\n");

/*  processing loop to control the voice output and decoder(s)  */
ploop:
        /* decode products */
        if (prodflg) {                          /* product available */
                prodflg--;                              /* get array indice */
                printf("\n\nProduct is:\n\n");
                bptr = &buf[prodflg];                   /* setup buf ptr */
                for (; inc() != 3;)
                        printf("%c", *bptr);
                bptr = &buf[prodflg];                   /* reset again */
                inc();                                  /* skip SOH */
                strgmv (&s, 9);                         /* trnsfr CCCNNNXXX */
                if (!strcmp (&s, "SLCSAOSLC"))
                        if (c = saodec(fdsao))          /* decode product */
                            printf("observation not decoded %d\n", c);
                prodflg = 0;                            /* clear prod flg */
        }

        /* user menu interface */
        if ((i = getchr()) == 3) {                      /* check for ctrl c */
                reset();
                fatal("System down\n");                 /* bye-bye */
        }
```

```
        goto ploop;                                     /* wait for another */
}
/*****************************************************************************
*                                                                            *
*                          F U N C T I O N S                                 *
*                                                                            *
*****************************************************************************/

/*****  name:  LOADIDX(IDX, NUM, FDIDX)
This routine loads an index (.IDX) file into a structure.  The phrase
number is trimmed off to save memory; therefore the phrase number must
be cataloged by the structure indice.  The number of elements in a
structure is contained in NUM.  The file "handle" is contained in FDIDX
and the structure address is contained in IDX.  Returns 1 on error.
global variables used:
        struct saoidx obs[]
routine callers:
        transmit()
*/
loadidx (idx, num, fdidx)
char idx[];                             /* struct and functions are pitiful */
                                        /* ... so we'll get sneaky */
int num;                                /* number of elements in the struct */
int fdidx;                              /* the index file descriptor */
{
        int i, j;                       /* general purpose counters */
        long pos;                       /* file position */
        char s[8];                      /* char array to hold data */

/*  set file position, read data, move data to the struct  */
        for (i = 0; i < num; i++) {
                pos = i * 8;                            /* find position */
                j = i * 6;                              /* struct offset */
                if (Dseek (fdidx, pos, 0) == ERROR)     /* set pos */
                        return(1);                      /* error return */
                if (Dread (fdidx, (unsigned) 8, &s) == ERROR)
                        return(1);                      /* error return */
                movmem (&s[2], &idx[j], 6);             /* fill struct */
        }
        return(0);                                      /* normal return */
}

/*****  name:  SAODEC(FDSAO)
This routine decodes a surface aviation observation and encodes a
message for broadcast on NWR.  The message is loaded into the program
file.
global variables used:
        struct pgm              ;program file
        buf[]                   ;data buffer
        *bptr                   ;buffer pointer
routine callers:
        main()
*/
saodec(fdsao)
int fdsao;                                      /* sao file descriptor */
{
        int wx[wxmax+2];                        /* current weather array */
        int vis;                                /* visibility number */
        int tym;                                /* synoptic time */
        int i, j;                               /* general purpose counters */
```

```
        int temp;                       /* temperature variable */
        int temp1, temp2;               /* general purpose integers */
        char *ptr;                      /* general char ptr */
        char s[10];                     /* general purpose array */
        char cflg;                      /* continue on flag */
        char thinflg, niteflg;          /* thin sky cvr and nite flg */

/*  initialize arrays and pointers  */
        pgmptr = 0;                     /* set pgm ptr to beginning */
        for (i = 0; i < wxmax + 2; i++)
                wx[i] = 0;              /* clear current wx array */

/*  check if obs is an 'SA' or 'RS'  */
        parse(lf);                      /* skip CCCNNNXXX */
        parse(lf);                      /* skip WOUS/TTAA line */
        parse(sp);                      /* skip stn id */
        if (inc() != 'R' && *bptr != 'A')
                return(1);              /* toss specials */
        parse(sp);                      /* skip to time group */
        if (isalpha(*bptr))             /* COR, AMD, etc? */
                parse(sp);              /* skip COR, etc */

/*  check time  */
        i = 0;                                  /* init counter */
        while (*bptr != sp)                     /* grab time grp */
                s[i++] = inc();
        s[i] = 0;                               /* terminate string */
        temp1 = atoi(&s);                       /* convert to int */
        temp1 = (temp1 + 70)/100;               /* calculate hour */
        if (temp1 == 24)                        /* 00Z? */
                temp1 = 0;                      /* reset */
        temp2 = time(&s[0]);                    /* get sys time */
        temp2 = (temp2 + 70)/100;               /* get hour again */
        if (temp1 != temp2)                     /* compare times */
                return(2);                      /* bad time - error */
        tym = temp2;                            /* save synop time */

/*  start the pgm with a greeting  */
        temp1 = (s[0] + 30)/60 + s[1] - zofst;  /* local time hour */
        if (temp1 < 0)                          /* make adjustments */
                temp1 += 24;
        else if (temp1 > 23)
                temp1 = 0;

        /* put the greeting into pgm */
        if (temp1 < 12)                         /* Good morning. */
                loadpgm(&obs[111], fdsao);
        else if (temp1 > 17)                    /* Good evening. */
                loadpgm(&obs[113], fdsao);
        else                                    /* Good afternoon. */
                loadpgm(&obs[112], fdsao);
        if (temp1 > 17 || temp1 < 9)            /* dark frm 6pm-8am */
                niteflg = 1;
        else
                niteflg = 0;                    /* let the sun shine */

/*  put the obs time in pgm message  */
        loadpgm(&obs[114], fdsao);              /* Current weather...*/

        /* what time is it? */
```

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        if (temp1 == 12)                        /* noon */
                loadpgm(&obs[118], fdsao);
        else if (temp1 == 0)                    /* at the stroke of..*/
                loadpgm(&obs[116], fdsao);
        else {                                  /* regular hour */
                if (temp1 < 12) {
                        loadpgm(&obs[temp1], fdsao);
                        loadpgm(&obs[117], fdsao);      /* am */
                }
                else {
                        temp1 -= 12;
                        loadpgm(&obs[temp1], fdsao);
                        loadpgm(&obs[119], fdsao);      /* pm */
                }
        }

/*  sky conditions  */
        cflg = 1;                       /* set the continue on flag */
        while (cflg) {
                parse(sp);              /* get a char */
                alpha();                /* get a non-digit char */
                if (*bptr == '-') {
                        thinflg = 1;    /* set the thin cloud flg */
                        inc();          /* increment pointer */
                }
                else
                        thinflg = 0;    /* clear cloud flag */
                switch (*bptr) {
                    case 'C':           /* clear */
                        wx[0] = 120;
                        if (niteflg)            /* sun set already? */
                            wx[0] += 1;
                        cflg = 0;
                        break;
                    case 'E':
                    case 'M':
                        break;          /* skip ceiling indicator */
                    case 'S':           /* scattered cloud deck */
                        if (thinflg) {
                            wx[0] = 122;        /* mostly sunny */
                            if (niteflg)        /* sun down? */
                                wx[0] += 1;
                        }
                        else
                            wx[0] = 124;        /* partly cloudy */
                        break;
                    case 'B':           /* broken cloud deck */
                        if (thinflg)
                            wx[0] = 124;        /* partly cloudy */
                        else
                            wx[0] = 125;        /* mostly cloudy */
                        break;
                    case 'O':           /* overcast cloud deck */
                        if (thinflg)
                            wx[0] = 125;        /* mostly cloudy */
                        else
                            wx[0] = 126;        /* cloudy skies */
                        break;
                    case '/':                   /* all done here */
                    case 'W':                   /* skip sky, get wx */
```

```
                case 'X':
                default:                        /* cur wx or errors */
                    cflg = 0;
            }
        }
        if (*bptr != slash)                     /* find a slash */
                parse(slash);
        unparse(sp);                            /* backup to a space */
        inc();                                  /* get on a valid char */
        if (isdigit(inc()) && isdigit(inc()) && isdigit(*bptr))
                unparse(sp);                    /* at sea level pressure */
        unparse(sp);                            /* near the visibility */

/*  decode visibility  */
        while (!isalpha(*bptr))                 /* find end of sky cover */
                dec();
        parse(sp);                              /* at begin of vis */
        for (i = 0; isdigit(*bptr); inc())
                s[i++] = *bptr;                 /* extract the vis */
        if (*bptr == sp) {                      /* ran into a space */
                inc();                          /* move frwd two chars */
                inc();
                if (*bptr == slash) {           /* vis a fraction? */
                        dec();                          /* decrement bptr */
                        s[i++] = *bptr;                 /* extract fraction */
                        inc();                          /* skip slash */
                        inc();
                        for (;isdigit(*bptr); inc())
                                s[i++] = *bptr; /* grab the rest */
                        s[i++] = '0';           /* multiply by 10 */
                }
                else {
                        dec();                  /* nice day, backup to sp */
                        dec();
                }
        }
        else if (*bptr == slash) {              /* no sp betwn vis fraction */
                for (inc(); isdigit(*bptr); inc())
                        s[i++] = *bptr; /* grab the rest */
                s[i++] = '0';                   /* multiply by 10 */
        }
        s[i] = 0;                               /* terminate string */
        vis = atoi(&s);                         /* convert vis to integer */

/*  current weather, or atmospheric phenomena  */
        cflg = 0;                               /* set the continue flag */
        while (cflg < wxmax)
            switch (inc()) {
                case ' ':                       /* no wx or end of wx */
                    cflg = wxmax;                       /* terminate scan */
                    break;
                case 'T':                       /* thunder? eeek!! */
                    if (extend(cflg, &wx))      /* extend phrase */
                            break;
                    wx[cflg++] = 139;                           /* T */
                    cflg = ltg(cflg, &wx);      /* check for ltg */
                    break;
                case 'R':                       /* raining */
                    if (extend(cflg, &wx))
                            break;
```

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        if (*bptr == 'W') {                 /* RW */
                wx[cflg++] = 131;
                inc();              /* incr ptr */
        }
        else
                wx[cflg++] = 129;           /* R */
        cflg = intensity(cflg, &wx);        /* + or -? */
        break;
case 'L':               /* drizzle */
        if (extend(cflg, &wx))
                break;
        wx[cflg++] = 144;                   /* L */
        cflg = intensity(cflg, &wx);
        break;
case 'Z':               /* freezing precip, BRRRR */
        if (extend(cflg, &wx))
                break;
        if (*bptr == 'R')
                wx[cflg++] = 143;           /* ZR */
        else if (*bptr == 'L')
                wx[cflg++] = 145;           /* ZL */
        else
                return(3);                  /* error */
        inc();
        cflg = intensity(cflg, &wx);
        break;
case 'I':               /* ice (fog, crystals, pelts */
        if (extend(cflg, &wx))
                break;
        switch (inc()) {
            case 'F':
                wx[cflg++] = 157;           /* IF */
                break;
            case 'C':
                wx[cflg++] = 151;           /* IC */
                break;
            case 'P':
                wx[cflg++] = 146;           /* IP */
                break;
            default:
                return(4);                  /* error */
        }
        break;
case 'S':               /* get a shovel, its snow */
        if (extend(cflg, &wx))
                break;
        switch (inc()) {
            case 'W':
                wx[cflg++] = 148;           /* SW */
                break;
            case 'G':
                wx[cflg++] = 150;           /* SG */
                break;
            case 'P':
                wx[cflg++] = 149;           /* SP */
                break;
            default:
                wx[cflg++] = 147;           /* S */
                dec();                      /* backup */
        }
```

```
        cflg = intensity(cflg, &wx);     /* intensity */
        break;
    case 'B':               /* blowing stuff */
        if (extend(cflg, &wx))
                break;
        switch (inc()) {
            case 'D':
                wx[cflg++] = 156;        /* BD */
                break;
            case 'N':
                wx[cflg++] = 155;        /* BN */
                break;
            case 'S':
                wx[cflg++] = 154;        /* BS */
                break;
            case 'Y':
                wx[cflg++] = 159;        /* BY */
                break;
            default:
                return(5);               /* error */
        }
        break;
    case 'A':               /* OUCH! hail */
        if (extend(cflg, &wx))
                break;
        wx[cflg++] = 152;                /* A */
        break;
    case 'H':               /* haze */
        if (extend(cflg, &wx))
                break;
        wx[cflg++] = 135;                /* H */
        break;
    case 'K':               /* smoke */
        if (extend(cflg, &wx))
                break;
        wx[cflg++] = 133;                /* K */
        break;
    case 'D':               /* dust */
        if (extend(cflg, &wx))
                break;
        wx[cflg++] = 158;                /* D */
        break;
    case 'G':               /* ground fog */
        if (extend(cflg, &wx))
                break;
        if (*bptr == 'F')
                wx[cflg++] = 153;        /* GF */
        else
                return(6);               /* error */
        break;
    case 'F':               /* fog */
        if (extend(cflg, &wx)) {
                j = cflg;        /* put fog at begin */
                for (i = cflg-1; i >= 0;)
                        wx[j--] = wx[i--];
                wx[0] = 128;     /* fog and ... */
                cflg++;
        }
        else
                wx[cflg++] = 127;        /* F */
```

```
                    break;
                case plus:                          /* intensity symbol */
                case minus:
                    break;                                  /* ignore */
                default:
                    return(7);                      /* error processing */
                }
        loadpgm(&obs[115], fdsao);
        for (i = 0; wx[i] > 0; i++)
                loadpgm(&obs[wx[i]], fdsao);

/*  decode the air temperature  */
        fill(&s);                               /* get the temperature */
        if (missing(&s))                        /* missing or est data */
                goto dewpt;                     /* skip air temp */
        temp = atoi(&s);                        /* convert to int */
        if (abs(temp) > 110)                    /* within voice data limit? */
                return(12);
        templd (temp, 176, fdsao);              /* load temp into pgm */

/*  decode the dewpoint  */
dewpt:
        fill(&s);                               /* get the dewpoint */
        if (missing(&s))                        /* any problems? */
                goto ddff;
        temp2 = atoi(&s);
        if (abs(temp2) > 110)                   /* check limit again */
                return(13);
        templd (temp2, 179, fdsao);             /* load dwpt into pgm */

/*  decode the relative humidity  */
        loadpgm(&obs[180],fdsao);                       /* rh _____ */
        i = rh(temp, temp2);                            /* do calculation */
        loadpgm(&obs[i], fdsao);                        /* value */
        loadpgm(&obs[181], fdsao);                      /* percent */

/*  put the visibility into the program  */
        if (vis > 20 && vis < 100)                      /* good vis, skip */
                goto ddff;
        loadpgm(&obs[160], fdsao);              /* visibility, ______ */
        if (vis == 1)
                loadpgm(&obs[173], fdsao);              /* one mile */
        else if (vis < 111) {
                loadpgm(&obs[vis], fdsao);              /* number */
                loadpgm(&obs[161], fdsao);              /* miles */
        }
        else {                                          /* fraction vis */
                temp1 = vis / 1000;                     /* mile or sixteenth */
                temp2 = (vis % 1000) / 100;             /* numerator */
                vis = (vis % 100) / 10;                 /* denominator */
                switch (vis) {                          /* separate denom */
                    case 2:                     /* halves */
                        vis = 169;
                        break;
                    case 4:                     /* quarters */
                        if (temp2 == 3)                 /* three quarters */
                            vis = 171;
                        else                            /* one quarter */
                            vis = 166;
                        break;
```

```
                case 6:                 /* sixteenths */
                    switch (temp1) {
                        case 1:         /* one sixteenth */
                            vis = 163;
                            break;
                        case 3:         /* three sixteenths */
                            vis = 165;
                            break;
                        case 5:         /* five sixteenths */
                            vis = 167;
                            break;
                        default:        /* error */
                            return(8);
                    }
                    temp1 = 0;          /* reset temp1 */
                    break;
                case 8:                 /* eighths */
                    switch (temp2) {
                        case 1:         /* one eighth */
                            vis = 164;
                            break;
                        case 3:         /* three eighths */
                            vis = 168;
                            break;
                        case 5:         /* five eighths */
                            vis = 170;
                            break;
                        case 7:         /* seven eights */
                            vis = 172;
                            break;
                        default:
                            return(9);
                    }
                    break;
                default:                /* error */
                    return(10);
            }
            if (temp1) {                /* ...miles */
                    loadpgm(&obs[173+temp1], fdsao);
                    loadpgm(&obs[vis], fdsao);
                    loadpgm(&obs[161], fdsao);
            }
            else {                      /* ...of a mile */
                    loadpgm(&obs[vis], fdsao);
                    loadpgm(&obs[162], fdsao);
            }
        }

/*  extract the wind direction and velocity  */
ddff:
        fill(&s);                       /* isolate the wind grp */
        if (missing(&s))                /* wnd missing */
                goto barom;             /* no wnd, goto barometer */
        temp1 = atoi(&s);               /* convert to integer */
        temp2 = temp1 % 100;            /* speed in knots */
        temp1 = temp1 / 100;            /* direction */
        if (temp2 < 2) {                /* calm? */
                loadpgm(&obs[197], fdsao);
                goto barom;             /* Winds are calm. */
        }
```

```
else if (temp2 < 7) {                   /* possibly LGT VRBL */
        ptr = bptr;                     /* save buffer pointer */
        parse('W');                     /* find a WND */
        while (inc() == 'W')            /* got a 'W'? */
            if (inc() =='N' && *bptr == 'D') {
                parse('V');             /* find VRBL */
                while (inc() == 'V')
                    if (inc() == 'R' && *bptr == 'B') {
                        loadpgm(&obs[198], fdsao);
                        bptr = ptr;     /* restore bptr */
                        goto barom;
                    }
            }
        bptr = ptr;                     /* restore pointer */
}
/* just normal wind, with possible gusts */
switch (temp1) {
        case 34:
        case 35:
        case 36:
        case 1:
        case 2:
        case 3:
                wx[0] = 189;                    /* north wind */
                break;
        case 4:
        case 5:
        case 6:
                wx[0] = 190;                    /* northeast wind */
                break;
        case 7:
        case 8:
        case 9:
        case 10:
        case 11:
        case 12:
                wx[0] = 191;                    /* east wind */
                break;
        case 13:
        case 14:
        case 15:
                wx[0] = 192;                    /* southeast wind */
                break;
        case 16:
        case 17:
        case 18:
        case 19:
        case 20:
        case 21:
                wx[0] = 193;                    /* south wind */
                break;
        case 22:
        case 23:
        case 24:
                wx[0] = 194;                    /* southwest wind */
                break;
        case 25:
        case 26:
        case 27:
        case 28:
```

```
                case 29:
                case 30:
                        wx[0] = 195;                    /* west wind */
                        break;
                case 31:
                case 32:
                case 33:
                        wx[0] = 196;                    /* northwest wind */
                        break;
                default:                                /* error return */
                        return(11);
        }
        loadpgm(&obs[wx[0]], fdsao);    /* Winds are from the ... */
        temp2 *= 1.152;                 /* convert kts to mph */
        loadpgm(&obs[temp2], fdsao);
        for (i = 0; s[i] != 'G' && s[i] != 'Q' && s[i]; i++);
        if (s[i] == 'G' || s[i] == 'Q') {       /* gusting winds? */
                loadpgm(&obs[188], fdsao);      /* ...mph, gusting...*/
                i++;                            /* skip letter */
                temp2 = atoi(&s[i]) * 1.152;    /* convert to mph */
                loadpgm(&obs[temp2], fdsao);
        }
        loadpgm(&obs[187], fdsao);              /* mph */

/*  decode the altimeter setting  */
barom:
        parse(slash);                           /* get to the data */
        inc();
        for (i = 0; *bptr != slash && *bptr != sp && *bptr != etx;)
                s[i++] = inc();                 /* fill the array */
        s[i] = 0;                               /* terminate string */
        if (missing(&s))                        /* bad data? */
                goto term;
        loadpgm(&obs[199], fdsao);              /* The barometer... */
        temp2 = atoi(&s);                       /* convert to int */
        if (s[0] < '4') {                       /* less than 35" */
                temp1 = 30 + s[0] - '0';        /* convert to binary */
                temp2 += 3000;                  /* get full value */
                loadpgm(&obs[temp1], fdsao);
        }
        else {                                  /* greater than 24" */
                temp1 = 20 + s[0] - '0';
                temp2 += 2000;                  /* get full value */
                loadpgm(&obs[temp1], fdsao);
        }
        loadpgm(&obs[203], fdsao);              /* ____ point ____ */
        s[1] -= '0';                            /* strip the ASCII */
        s[2] -= '0';
        loadpgm(&obs[s[1]], fdsao);             /* stuff # aft point */
        loadpgm(&obs[s[2]], fdsao);
        if (oldalt > temp2)                     /* falling */
                loadpgm(&obs[200], fdsao);
        else if (oldalt < temp2)                /* rising */
                loadpgm(&obs[202], fdsao);
        else                                    /* steady */
                loadpgm(&obs[201], fdsao);
        oldalt = temp2;                         /* setup prev value */

/*  terminate the program format  */
term:
```

```
/* first handle any supplimental data */
if (tym == 12 || tym == 0) {
        parse(etx);                 /* find product end */
        unparse(slash);             /* find a slash */
        inc();                      /* need a slash, space */
        while (!isspace(*bptr) && *bptr != soh) {
                unparse(slash); /* keep looking for a "/ " */
                unparse(slash);
                inc();
        }
        i = 0;                      /* init counter */
        cflg = 0;                   /* set first time thru flg */
        while (i == 0 && *bptr != etx) {
                parse(sp);          /* skip over space */
                if (*bptr == '4' && cflg) {     /* 4TTTT gp? */
                        ptr = bptr;     /* save pointer */
                        parse(sp);      /* find end of group */
                        if ((bptr - ptr) > 5) { /* max/min */
                            bptr = ptr;         /* restore */
                            inc();              /* skip 4 */
                            if (tym) {          /* skip max */
                                inc();
                                inc();
                            }
                            s[i++] = inc();     /* grab temp */
                            s[i++] = *bptr;
                            break;
                        }
                        else                    /* process.. */
                            bptr = ptr;         /* normally */
                }
                else                            /* reset flg */
                        cflg = 1;
                for (; isdigit(*bptr) && *bptr != etx; i++)
                        s[i] = inc();   /* extract a data gp */
                s[i] = 0;
                if (i > 2)      /* min/max must be 2 digits */
                        i = 0;  /* try again */
                else
                        s[i] = 0;       /* terminate */
        }
        minmax = atoi(&s[0]);           /* convert to int */
        if (i == 0 || abs(minmax) > 110) {      /* temp ok? */
                minmax = -9999;         /* data missing flg */
                goto cont;
        }
        if (tym) {              /* min */
                if (temp < minmax)      /* less than zero? */
                        minmax -= 100;
                templd (minmax, 182, fdsao);
        }
        else {
                if (temp > minmax)      /* greater than 100 */
                        minmax += 100;
                if (temp < 0 && minmax > 50)
                        minmax -= 100;  /* brrrr */
                templd (minmax, 183, fdsao);
        }
}
```

```
        else if ((tym == 13 || tym == 14) && minmax != -9999)
                templd(minmax, 182, fdsao);     /* min restored */
        else if ((tym == 1 || tym == 2) && minmax != -9999)
                templd(minmax, 183, fdsao);     /* max restored */
        else
                minmax = -9999;                 /* clear minmax */

cont:
        tpgm[pgmptr].tp_fd = -1;            /* terminate program */
        tpgm[pgmptr].tp_high = oldalt;      /* save alt reading */
        tpgm[pgmptr].tp_low = minmax;       /* save min/max temp */

        /* archive the current pgm */
        temp1 = Dopen(1, "pgmfile");
        if (Dwrite(temp1, (pgmphr + 1) * 8, &tpgm[0]) == ERROR)
                fatal ("unable to write to PGMFILE\n");
        Dclose (temp1);

        /* update the old pgm with the new one */
        swappg((pgmphr+1) * 4, &tpgm[0], &pgm[0]);
        return(0);                          /* normal return */
}

/****    name:  extend(n, w)
This routine ensures the current weather phrase (We have _____.) can be
properly extended to allow for additional weather phenomena.
global variables used:
        none
routine callers:
        saodec()
*/
extend(n, w)
int n;                              /* the array indice */
int w[];                            /* current weather array */
{
        int i;                              /* general purpose variable */

        if(!n)                              /* no need to check first */
                return(0);
        i = n - 1;                          /* decrement array indice */
        if (w[i] > 126 && w[i] < 141) {          /* can we extend? */
                w[i] += 1;                       /* yes, so do it */
                return(0);                       /* rtn, extend ok */
        }
        else
                return(1);                       /* rtn, not able to */
}

/****    name:  intensity(n, w)
This routine attaches an intensity to the observed weather phenomena.
If no intensity is found no changes are made.  The array indice is
returned.
global variables used:
        none
routine callers:
        saodec()
*/
intensity(n, w)
int n;                              /* array indice */
int w[];                            /* current weather array */
```

```
{
        int i;                          /* general purpose variable */

        i = n - 1;                      /* decrement indice */
        switch (*bptr) {
            case plus:                          /* heavy */
                w[n] = w[i];                    /* move element frwd */
                w[i] = 141;                     /* put in intensity */
                return(n+1);                    /* return indice */
            case minus:                         /* light */
                w[n] = w[i];
                w[i] = 142;
                return(n+1);
            default:                            /* no intensity */
                return(n);                      /* no changes */
        }
}

/****    name:  ltg(n, w)
This program finds the LTG contraction to determine if lightening is
present during the observation of a thunderstorm.
global variables used:
        char buf[]              ;product buffer
        char *bptr              ;buffer pointer
routine callers:
        saodec()
*/
ltg(n, w)
int n;                          /* current wx array indice */
int w[];                        /* current wx array */
{
        char *ptr;              /* temporary buffer pointer */

        ptr = bptr;                     /* save the current ptr */
        parse('L');                     /* find an L */
        while (inc() == 'L')
                if (inc() == 'T' && *bptr == 'G') {     /* fnd LTG? */
                        w[n-1] += 1;                    /* put ..and */
                        w[n++] = 137;                   /* put ltg */
                }
                else
                        parse('L');                     /* find L */
        bptr = ptr;                     /* restore pointer */
        return(n);                      /* return array indice */
}

/****    name:  fill(s)
This routine fills the string array (s) from buf until a slash is
found.
global variables used:
        buf[]                   ;buffer
        bptr                    ;buffer pointer
routine callers:
        saodec()
*/
fill(s)
char s[];
{
        int i;                  /* counter */
```

```
        parse(slash);                   /* get to data location */
        inc();                          /* ... */
        for (i = 0; *bptr != slash && *bptr != etx;)
                s[i++] = inc(); /* fill the array */
        s[i] = 0;                       /* terminate array */
        return(0);
}

/****    name:  missing(s)
This routine checks to see if the input data is estimated (preceded by
an 'E'), or if the data is missing (.../MM/...).  The estimated removes
the 'E' and returns 0; the missing data returns a 1.  If no changes are
required this routine returns a 0.
global variables used:
        none
routine callers:
        saodec()
*/
missing(s)
char s[];
{
        int i;                          /* general counter */

        if (s[0] == 'E')                /* estimated data */
                for (i = 0; s[i]; i++)  /* remove 'E' */
                        s[i] = s[i+1];
        if (isalpha(s[0]))              /* any other problems? */
                return(1);              /* error return */
        return(0);                      /* normal return */
}

/****    name:  templd(temp, n, fdsao)
This routine loads temperature data into the pgm structure.
global variables used:
        struct pgm              ;pgm structure
routine callers:
        saodec();
*/
templd(temp, n, fdsao)
int temp;                       /* input temperature */
int n;                          /* temp type (air or dwpt) */
int fdsao;                      /* file handle */
{
        loadpgm(&obs[n], fdsao);
        if (temp == 1)          /* one degree */
                loadpgm(&obs[177], fdsao);
        else if (temp == -1)    /* one degree below zero */
                loadpgm(&obs[184], fdsao);
        else if (temp >= 0) {   /* _____ degrees */
                loadpgm(&obs[temp], fdsao);
                loadpgm(&obs[178], fdsao);
        }
        else {                  /* _____ degrees below zero */
                temp = abs(temp);       /* remove negative */
                loadpgm(&obs[temp], fdsao);
                loadpgm(&obs[185], fdsao);
        }
        return(0);
}
```

```
/****    name:  rh(atem, dtem)
This routine calculates the relative humidity from the air and dewpoint
temperatures using the Clausis-Clapeyron equation.  The processed form
of the equation is:
                              R H = e/es * 100%
where es = the saturation vapor pressure, and
      e = the vapor pressure.
Upon entry this routine must have the temperature values in Fahrenheit,
and return the RH value in integer format.
reference used:
        Smithsonian Meteorological Tables, Sixth Revised Edition by
        Robert List; page 350.
global variables used:
        none
routine callers:
        saodec()
*/
rh(atem, dtem)
int atem, dtem;                         /* air and dewpoint temps */
{
        int i;                          /* integer return value */
        double es, e;                   /* vapor pressures */
        double vpabov(), vpbelo();      /* calculation functions */
        float t;                        /* converted temp value */

/*  air temperature calculation  */
        t = 5./9. * (atem - 32) + 273.16;       /* Fahr to Kelvin */
        if (t < 273.16)                         /* below freezing? */
                es = vpbelo(t);
        else
                es = vpabov(t);                 /* above zero C */

/*  dewpoint temperature calculation  */
        t = 5./9. * (dtem - 32) + 273.16;       /* Kelvin again */
        if (t < 273.16)
                e = vpbelo(t);
        else
                e = vpabov(t);

/*  calculate rh  */
        i = e/es * 100;
        printf("rh = %d\n", i);
        return(i);
}

/****    name:  vpbelo(t)
This routine calculates the vapor pressure for temperature below
freezing, and return this value.
global variables used:
        none
routine callers:
        rh()
*/
double vpbelo(t)
double t;
{
        extern double log10(), pow();           /* math functions */
        float x1, x2;                           /* general variables */
        double e;                               /* vapor pressure */
```

```
/*  calculate the vapor pressure  */
        x1 = 273.16 / t;                        /* wrt ice */
        x2 = t / 273.16;
        e = -9.09718*(x1 - 1) - 3.56654*(log10(x1)) + 0.87679*(1 - x2);
        e = e + 0.78584;
        e = pow( (double) 10, e);               /* get the inv log */
        return(e);
}

/****    name:  vpabov(t)
This routine calculates the vapor pressure for temperatures above
freezing and return the value.
global variables used:
        none
routine callers:
        rh()
*/
double vpabov(t)
double t;                                   /* input temperature */
{
        extern double log10(), pow();           /* math functions */
        float x1, x2;                           /* general variables */
        double e;                               /* vapor pressure */

/*  calculate the vapor pressure  */
        x1 = 373.16 / t;                        /* wrt water */
        x2 = t / 373.16;
        e = -7.90298 * (x1 - 1) + 5.02808 * (log10(x1)) + 3.00572;
        x1 = -3.49149 * (x1 - 1);
        x2 = 11.344 * (1 - x2);
        x1 = pow( (double) 10, x1) - 1.0;
        x2 = pow( (double) 10, x2) - 1.0;
        e = e - (1.38e-7 * x2) + (8.13828e-3 * x1);
        e = pow( (double) 10, e);
        return(e);
}
/** end of the sao decoder functions **/

/*****  name:  ALPHA()
This routine finds an char which is not a digit or a space.  The buffer
pointer (*bptr) is left on this char upon return.
global variables used:
        char buf[]              ;product buffer
        char *bptr              ;buffer pointer
routine callers:
        saodec()
*/
alpha()
{
        while ((isdigit(*bptr) || isspace(*bptr)) && *bptr != etx)
                inc();          /* increment buf pointer */
        return(0);                      /* return to caller */
}

/*****  name:  PARSE(C)
THis routine parses for a specified character (c) in buf[].  All white
space characters are parsed through with the pointer left on the next
valid ascii character.
global variables used:
        char buf[]              ;product buffer
```

```
        char *bptr                  ;buffer pointer
routine callers:
        saodec()                    fill()
*/
parse(c)
char c;                             /* the char to find */
{
        if (c == sp)                /* white space? */
                while (!isspace(*bptr) && *bptr != etx)
                        inc();              /* find a space */
        else                        /* specific char requested */
                while (*bptr != c)
                        inc();              /* find the char */
        while (isspace(*bptr) && *bptr != etx)
                inc();                      /* leave ptr on char */
        return(0);
}

/***** name:  UNPARSE(C)
This routine moveS backward through the product buffer (buf[]) to find
the specified char.  The buffer pointer (*bptr) is left on this char.
global variables used:
        char buf[]                  ;product buffer
        char *bptr                  ;buffer pointer
routine callers:
        saodec()
*/
unparse(c)
char c;                             /* char requested to find */
{
        dec();                      /* backup one char */
        if (c == sp)                        /* white space? */
                while (!isspace(*bptr) && *bptr != soh)
                        dec();  /* keep going */
        else                                /* specific character */
                while (*bptr != c && *bptr != soh)
                        dec();
        return(0);
}

/***** name:  LOADPGM (INFO, FD)
This routine fills the program structure (prepgm).  Upon entry INFO
contains the phrase number and FD contains the .PHS file handle.  This
routine increments the program pointer (pgmptr) and always returns
zero.
global variables used:
        struct prepgm
        pgmptr
routine callers:
        saodec()                    templd()
*/
loadpgm(info, fd)
int info[];                         /* location of phrase data */
int fd;                             /* file handle of phrase data */
{
        tpgm[pgmptr].tp_fd = fd;                    /* file descriptor */
        tpgm[pgmptr].tp_high = info[0];             /* high offset */
        tpgm[pgmptr].tp_low = info[1];              /* low offset */
        tpgm[pgmptr].tp_length = info[2];           /* phrase length */
        pgmptr++;                                   /* inc pointer */
```

```
        if (pgmptr > pgmphr)
                fatal("Pgm file full, change pgmphr in define.c\n");
        return(0);
}

/***** name:  FATAL(S)
This routine handles all fatal errors by displaying the string (S) and
beeping.  If this routine is called, the IBM will return to DOS and
program execution will stop!!
global variables used:
        none
routine callers:
        main            fetch
*/
fatal(s)
char *s;
{
        printf("%s", s);                        /* display error msg */
/*      beep();                                 /* assembler beep routine */
*/
        exit();
}

/***** name:  STRGMV(S, N)
This routine fills the S char array with the specified number of chars
(N) from buf[].
global variables used:
        buf[]           ;buffer
        bptr            ;buffer pointer
routine callers:
        main()
*/
strgmv(s, n)
char s[];
int n;
{
        int i;                                  /* counter */
        for (i = 0; i < n; i++)
                s[i] = inc();                   /* fill array */
        s[i] = 0;                               /* terminate string */
        return(0);                              /* return to caller */
}

/***** name:  INC() and DEC()
These routine maintain the buffer pointer (*bptr) and return the
current character pointed to by *bptr.  All pointer incrementing or
decrementing must be done by these routines to avoid reading past the
circular buffer ending location.  These routines can be thought of as:

        INC() = bptr++;
        DEC() = *bptr--;
global variables used:
        buf[]                   ;buffer
        bptr                    ;buffer pointer
routine callers:
        saodec()        alpha()         parse()
        unparse()       fill()          ltg()
*/
char inc()
{
```

```
        char c;                         /* return character */
        c = *bptr;                      /* grab char */
        ++bptr;                         /* update pointer */
        if (bptr >= &buf[maxbuf])       /* past buffer end? */
                bptr = &buf[0];         /* set pointer to begin */
        return(c);                      /* return to caller */
}
char dec()
{
        char c;                         /* same logic as inc() */
        c = *bptr;
        --bptr;
        if (bptr < &buf[0])
                bptr = &buf[maxbuf];
        return(c);
}
```

```
/*      date: february 1985                                    extern.c
        version: 1.0
        by: glen w. sampson

  This file contains all of the extern (global) declarations for use by
the voice synthesis program(s).  This file partially incorporates the
Vynet file mface.inc.
*/

/*  external references for Vynet driver functions  */
extern int FCN_0 ();
extern int FCN_1 ();
extern int FCN_2 ();
extern int FCN_3 ();
extern int FCN_4 ();
extern int FCN_5 ();
extern int FCN_6 ();
extern int FCN_7 ();
extern int FCN_8 ();
extern int FCN_9 ();
extern int FCN_10 ();
extern int FCN_11 ();
extern int FCN_12 ();
extern int FCN_13 ();
extern int FCN_14 ();
extern int FCN_15 ();
extern int FCN_16 ();
extern int FCN_17 ();
extern int FCN_18 ();
extern int FCN_19 ();
extern int FCN_20 ();
extern int FCN_21 ();
extern int FCN_22 ();
extern int FCN_23 ();
extern int FCN_24 ();
extern int FCN_25 ();
extern int FCN_26 ();
extern int FCN_27 ();
extern int DOPEN  ();
extern int DSEEK  ();
extern int DREAD  ();
extern int DWRITE ();
extern int DCLOSE ();
extern int SET_STAC ();
extern int CHK_DRV ();

/*  structures used to manage .IDX files and program content  */
        /** hourly observation index catalog **/
struct saoidx {
        int sa_high;                    /* hi order location */
        int sa_low;                     /* lo order location */
        unsigned int sa_length;         /* length of phrase */
} obs[saophr];                          /* phrase # and quantity */

        /** program of phrases **/
struct pgmidx {
        int pg_fd;                      /* phrase file number */
        int pg_high;                    /* hi order phrase location */
        int pg_low;                     /* low order location */
        unsigned int pg_length;         /* length of phrase */
```

```
} pgm[pgmphr + 1];

        /** program assembly structure **/
struct prepgm {
        int tp_fd;                          /* same as above struct */
        int tp_high;
        int tp_low;
        unsigned int tp_length;
} tpgm[pgmphr + 1];

/*  general variables and array initialization  */
char header[] = {1,0,6,0,0,0,2};            /* phrase header */
char *ptr1;                                 /* voice data buf pointer */
char *ptr2;                                 /* vd #2 buffer pointer */
char buf[maxbuf+1];                         /* raw data input buffer */
char *bptr;                                 /* buf[] pointer */
int pgmptr;                                 /* program pointer (indice) */
int oldalt;                                 /* prev obs altimeter readng */
int minmax;                                 /* min/max temp data */
int prodflg;                                /* product received flag */
int _stack = 4096;                          /* declare stack space */
```

define.c

```
/*      date:  february 1985
        version: 1.0
        by: glen w. sampson

  This file contains all of the parameter (#define) statements used in
the voice synthesis program(s).  This file incorporates portions of the
Vynet mface.inc file.
*/

/*  symbolic name to Vynet firmware function for 'C' calls  */
#define Init                    FCN_0
#define OffHook                 FCN_1
#define OnHook                  FCN_2
#define RingOff                 FCN_3
#define ChkRing                 FCN_4
#define DialTone                FCN_5
#define DialPl                  FCN_6
#define DialTnSt                FCN_7
#define DialPlSt                FCN_8
#define OfDlTnSt                FCN_9
#define OfDlPlSt                FCN_10
#define RdTone                  FCN_11
#define RdToneSt                FCN_12
#define ChkTone                 FCN_13
#define WriteVs                 FCN_14
#define ReadVs                  FCN_15
#define Speak                   FCN_16
#define RdAlpha                 FCN_17
#define RdAlpSt                 FCN_18
#define Delay                   FCN_19
#define InitInt                 FCN_20
#define Flash                   FCN_21
#define WaitDlTn                FCN_22
#define StartSd                 FCN_23
#define StopSd                  FCN_24
#define WaitBsAn                FCN_25
#define RdTnStEn                FCN_26
#define ChkStat                 FCN_27
#define Dopen                   DOPEN
#define Dseek                   DSEEK
#define Dread                   DREAD
#define Dwrite                  DWRITE
#define Dclose                  DCLOSE
#define SetStack                SET_STAC
#define ChkDrv                  CHK_DRV

/*  Vynet driver status codes  */
#define SUCCESS         0x0080  /* I/O complete */
#define NO_FUNCTION     0x0081  /* invalid function number */
#define WAITING         0x0082  /* I/O pending */
#define BAD_DIGIT       0x0083  /* bad dial tone string digit */
#define TIMEOUT         0x0084  /* function timed out w/o completion */
#define OVERRUN         0x0085  /* read tone string overrun */
#define NOT_ALPHA       0x0086  /* invalid alpha code */
#define NO_HARDWARE     0x0087  /* no hardware on channel */
#define NOT_AVAILABLE   0x0088  /* function not implemented */
#define UNDERRUN        0x0089  /* speech overrun */
#define NO_INTERRUPT    0x008A  /* spurious interrupt */

/*  DOS error codes  */
```

```
#define ERROR    -1

/*  I/O channel numbers for voice board  */
#define outchn   0                  /* output channel (speaking) */
#define inchn    1                  /* input channel (recording) */

/*  array dimensions and initialization  */
#define pgmphr   50                 /* max # of phrases in pgm broadcast */
#define saophr   204                /* exact # of phrases for obs encode */
#define wxmax    3                  /* # of curnt wx conds reportable */
#define zofst    7                  /* hours added to local time for GMT */
#define maxbuf   1024               /* buf size, maxbuf < 64K ALWAYS!!! */

/*  frequently used parameters  */
#define soh      01                 /* start of text */
#define etx      03                 /* end of text */
#define lf       10                 /* line feed */
#define cr       13                 /* carriage return */
#define sp       32                 /* space */
#define plus     43                 /* + */
#define minus    45                 /* - */
#define slash    47                 /* / */
```

ctype.h

```
/**
*
* This header file defines various ASCII character manipulation macros,
* as follows:
*
*       isalpha(c)     non-zero if c is alpha
*       isupper(c)     non-zero if c is upper case
*       islower(c)     non-zero if c is lower case
*       isdigit(c)     non-zero if c is a digit (0 to 9)
*       isxdigit(c)    non-zero if c is a hexadecimal digit (0 to 9, A to F,
*                      a to f)
*       isspace(c)     non-zero if c is white space
*       ispunct(c)     non-zero if c is punctuation
*       isalnum(c)     non-zero if c is alpha or digit
*       isprint(c)     non-zero if c is printable (including blank)
*       isgraph(c)     non-zero if c is graphic (excluding blank)
*       iscntrl(c)     non-zero if c is control character
*       isascii(c)     non-zero if c is ASCII
*       iscsym(c)      non-zero if valid character for C symbols
*       iscsymf(c)     non-zero if valid first character for C symbols
*
**/

#define _U 1            /* upper case flag */
#define _L 2            /* lower case flag */
#define _N 4            /* number flag */
#define _S 8            /* space flag */
#define _P 16           /* punctuation flag */
#define _C 32           /* control character flag */
#define _B 64           /* blank flag */
#define _X 128          /* hexadecimal flag */

extern char _ctype[];    /* character type table */

#define isalpha(c)       (_ctype[(c)+1]&(_U|_L))
#define isupper(c)       (_ctype[(c)+1]&_U)
#define islower(c)       (_ctype[(c)+1]&_L)
#define isdigit(c)       (_ctype[(c)+1]&_N)
#define isxdigit(c)      (_ctype[(c)+1]&_X)
#define isspace(c)       (_ctype[(c)+1]&_S)
#define ispunct(c)       (_ctype[(c)+1]&_P)
#define isalnum(c)       (_ctype[(c)+1]&(_U|_L|_N))
#define isprint(c)       (_ctype[(c)+1]&(_P|_U|_L|_N|_B))
#define isgraph(c)       (_ctype[(c)+1]&(_P|_U|_L|_N))
#define iscntrl(c)       (_ctype[(c)+1]&_C)
#define isascii(c)       ((unsigned)(c)<=127)
#define iscsym(c)        (isalnum(c)||((c)&127)==0x5f))
#define iscsymf(c)       (isalpha(c)||((c)&127)==0x5f))

#define toupper(c)      (islower(c)?((c)-('a'-'A')):(c))
#define tolower(c)      (isupper(c)?((c)+('a'-'A')):(c))
#define toascii(c)       ((c)&127)
```

stdio.h

```
/**
*
* This header file defines the information used by the standard I/O
* package.
*
**/
#define _BUFSIZ 512                 /* standard buffer size */
#define BUFSIZ 512                  /* standard buffer size */
#define _NFILE 20                   /* maximum number of files */

struct _iobuf
{
char *_ptr;                         /* current buffer pointer */
int _rcnt;                          /* current byte count for reading */
int _wcnt;                          /* current byte count for writing */
char *_base;                        /* base address of I/O buffer */
char _flag;                         /* control flags */
char _file;                         /* file number */
int _size;                          /* size of buffer */
char _cbuff;                        /* single char buffer */
char _pad;                          /* (pad to even number of bytes) */
};

extern struct _iobuf _iob[_NFILE];

#define _IOREAD 1                   /* read flag */
#define _IOWRT 2                    /* write flag */
#define _IONBF 4                    /* non-buffered flag */
#define _IOMYBUF 8                  /* private buffer flag */
#define _IOEOF 16                   /* end-of-file flag */
#define _IOERR 32                   /* error flag */
#define _IOSTRG 64
#define _IORW 128                   /* read-write (update) flag */

#if SPTR
#define NULL 0                      /* null pointer value */
#else
#define NULL 0L
#endif
#define FILE struct _iobuf          /* shorthand */
#define EOF (-1)                    /* end-of-file code */

#define stdin (&_iob[0])            /* standard input file pointer */
#define stdout (&_iob[1])           /* standard output file pointer */
#define stderr (&_iob[2])           /* standard error file pointer */

#define getc(p) (--(p)->_rcnt>=0? *(p)->_ptr++:_filbf(p))
#define getchar() getc(stdin)
#define putc(c,p) (--(p)->_wcnt>=0? ((int)(*(p)->_ptr++=(c))):_flsbf((c),p
#define putchar(c) putc(c,stdout)
#define feof(p) (((p)->_flag&_IOEOF)!=0)
#define ferror(p) (((p)->_flag&_IOERR)!=0)
#define fileno(p) (p)->_file
#define rewind(fp) fseek(fp,0L,0)
#define fflush(fp) _flsbf(-1,fp)
#define clearerr(fp) clrerr(fp)

FILE *fopen();
FILE *freopen();
long ftell();
```

```
char *fgets();

#define abs(x) ((x)<0?-(x):(x))
#define max(a,b) ((a)>(b)?(a):(b))
#define min(a,b) ((a)<=(b)?(a):(b))
```

B. Func.asm

Func.asm contains all of the assembler routines (except for mface.asm supplied by Vynet Corporation) used in the voice system. These routines include the asynchronous device drivers, and functions from the BIOS and BDOS levels of MS-DOS not found in Lattice C. The functions contained in this file are:

time	getchr	setcom	swappg
setread	setstat	reset	

The interrupt service routine addresses used in the setread and setstat functions are interrpt and talk, respectively.

func.asm

```
;       date:  april 1985
;       version:  1.0
;       by:  glen w. sampson
;
;Purpose:
;  These routines contain BIOS functions calls not normally available
;in C, and device drivers for the asynchronous communication adapters.
;
;Exits:
;  No exits exist from these routines.
;
;Created by:
;       (Version 1.0 IBM Macro Assembler)
;       C>masm func, func, nul, nul
;
;*****************************************************************************
; setup the proper memory model
S_MODEL         EQU     0
P_MODEL         EQU     0
D_MODEL         EQU     1
L_MODEL         EQU     0
;
;*****************************************************************************
; setup the stack offsets
        IF      L_MODEL OR P_MODEL                      ;FAR CALLS
FIRST_PARAM     EQU     6
SECOND_PARAM    EQU     8
THIRD_PARAM     EQU     10
FOURTH_PARAM    EQU     12
FIFTH_PARAM     EQU     14
SIXTH_PARAM     EQU     16
        ELSE
FIRST_PARAM     EQU     4                               ;NEAR CALLS
SECOND_PARAM    EQU     6
THIRD_PARAM     EQU     8
FOURTH_PARAM    EQU     10
FIFTH_PARAM     EQU     12
SIXTH_PARAM     EQU     14
        ENDIF
;
; *****************************************************************************
; declare external functions (if appropriate)
        IF P_MODEL OR L_MODEL
        EXTRN   TRANSMIT:FAR
        ENDIF
;
; *****************************************************************************
; establish the DATA SEGMENT
DGROUP  GROUP   DATA
DATA    SEGMENT WORD    PUBLIC  'DATA'
        ASSUME  DS:DGROUP
;
; declare externals and variables
        EXTRN   PRODFLG:WORD                            ;defined in C
        PTR0    DW      00H                             ;buffer pointer
        BEGIN0  DW      00H                             ;starting prod indice
        BUF0    DW      00H                             ;buffer defined in C
        BUF0SEG DW      00H                             ;SEG of buffer
        BUF0MAX DW      00H                             ;end of buffer
        BASE    DW      00H                             ;base seg adrs
```

```
        EXTRA   DW      00H                     ;extra seg reg
DATA    ENDS                                    ;end data segment
;
;*************************************************************************
; establish the GROUP and SEGMENT definitions
        IF      S_MODEL
PGROUP  GROUP   PROG
PROG    SEGMENT BYTE    PUBLIC  'PROG'
        ASSUME  CS:PGROUP
        ENDIF

        IF      P_MODEL
PGROUP  GROUP   CODE
_CODE   SEGMENT BYTE    PUBLIC  '_CODE'
        ASSUME  CS:PGROUP
        ENDIF

        IF      D_MODEL
CGROUP  GROUP   CODE
CODE    SEGMENT BYTE    PUBLIC  'CODE'
        ASSUME  CS:CGROUP
        ENDIF

        IF      L_MODEL
CGROUP  GROUP   _PROG
_PROG   SEGMENT BYTE    PUBLIC  '_PROG'
        ASSUME  CS:CGROUP
        ENDIF

;
;*************************************************************************
; put the hooks in for 'C' access
        PUBLIC  TIME
        PUBLIC  GETCHR
        PUBLIC  SETCOM
        PUBLIC  SWAPPG
        PUBLIC  SETREAD
        PUBLIC  SETSTAT
        PUBLIC  RESET
;
;
;*************************************************************************
;
;                       f u n c t i o n s
;
;*************************************************************************
;
;       name:   time(adrs)
;       version:  1.0
;  This routine retrieves a 2 byte value containing the hour and
;minutes.  These values are stored at input address.
;
        IF      S_MODEL OR D_MODEL
TIME_PROC       PROC    NEAR
        ELSE
TIME_PROC       PROC    FAR
        ENDIF

TIME:
        PUSH    BP                      ;STACK'EM UP
```

```
        MOV     BP,SP
        PUSH    DS
        MOV     AH,2CH                  ;GET TIME FUNCTION CALL
        INT     21H                     ;DOS CAN DO IT
        MOV     BX,FIRST_PARAM[BP]      ;GET OFFSET
    IF  L_MODEL OR D_MODEL
        MOV     AX,SECOND_PARAM[BP]     ;RETRIEVE SEGMENT ADRS
        MOV     DS,AX                   ;SETUP THE SEGMENT
    ENDIF
        MOV     DS:[BX],CX              ;STORE IN INPUT ADRS
        MOV     AL,CH                   ;PUT THE HOUR INTO 'A'
        MOV     BL,64H                  ;LOAD UP MULT OPERAND
        MUL     BL                      ;MULTIPLY BY 100
        AND     CX,0FFH                 ;ISOLATE THE MINUTES
        ADD     AX,CX                   ;COMBINE HOUR & MIN INTO INT
        POP     DS                      ;MOVE'EM OUT
        POP     BP
        RET                             ;RETURN TO CALLER
TIME_PROC       ENDP
;
;       name:  getchr()
;       version:  1.0
;  This routine retrieves a character from the keyboard (with an echo)
;and returns this character to the caller.
        IF      S_MODEL OR D_MODEL
GETCHR_PROC     PROC    NEAR
        ELSE
GETCHR_PROC     PROC    FAR
        ENDIF

GETCHR:
        PUSH    BP                      ;STACK 'EM
        MOV     BP,SP
        MOV     AH,01H                  ;READ STATUS AND GET CHAR
        INT     16H                     ;GO FOR IT
        JNZ     CLEAR                   ;WE GOT IT, CLEAR OUT CHAR
        XOR     AX,AX                   ;NO CHAR, CLEAR AX
        JMP     RTN                     ;RETURN TO CALLER
CLEAR:
        XOR     AH,AH                   ;ZERO 'AH' TO UPDATE KB BUF
        INT     16H                     ;GET CHAR, CLEAR KB BUFFER
        MOV     AH,0EH                  ;PUT IN VIDEO OUT CODE
        INT     10H                     ;ECHO...echo...
RTN:
        POP     BP
        RET                             ;ALL DONE
GETCHR_PROC     ENDP
;
;       name:  setcom(port, val)
;       version:  1.0
;  This routine uses the software interrupt INT 14H to initialize an
;asynchronous comms port.  Upon entry, port must be either 0 or 1
;(COM1 or COM2) and val must contain the initialization value.  This
;value is documented in the BIOS source listing.
;
        IF      S_MODEL OR D_MODEL
SETCOM_PROC     PROC    NEAR
        ELSE
SETCOM_PROC     PROC    FAR
        ENDIF
```

```
SETCOM:
        PUSH    BP                          ;stack up
        MOV     BP,SP
        MOV     DX,FIRST_PARAM[BP]          ;get port offset
        MOV     AX,SECOND_PARAM[BP]         ;set ax for call
        INT     14H                         ;set the comms port
        POP     BP
        RET
SETCOM_PROC     ENDP
;
;       name:  swappg(count, source adrs, dest adrs)
;       version:  1.0
;  This function swaps programs and ensures this swap is uninterrupted
;to avoid broadcasting half a new product and half an old product.
;Upon entry, count is the number of words to move, and the addresses
;are for the source and destination locations.

        IF S_MODEL OR D_MODEL
SWAPPG_PROC     PROC    NEAR
        ELSE
SWAPPG_PROC     PROC    FAR
        ENDIF

SWAPPG:
        PUSH    BP                          ;STACK 'EM UP
        MOV     BP,SP
        PUSH    ES
        PUSH    DS
        PUSH    DI
        PUSH    SI
        MOV     CX,FIRST_PARAM[BP]          ;SETUP THE COUNTER
        MOV     SI,SECOND_PARAM[BP]         ;SOURCE OFFSET
      IF D_MODEL OR L_MODEL
        MOV     AX,THIRD_PARAM[BP]          ;SOURCE SEGMENT
        MOV     DS,AX
        MOV     DI,FOURTH_PARAM[BP]         ;DEST OFFSET
        MOV     AX,FIFTH_PARAM[BP]          ;DEST SEGMENT
        MOV     ES,AX
      ELSE
        MOV     DI,THIRD_PARAM[BP]          ;DEST OFFSET
        MOV     ES,DS                       ;FINISH ADRSING SETUP
      ENDIF
        CLI                                 ;DISABLE INTERRUPTS
        STI                                         ;REENABLE INTERRUPTS
REP     MOVSW                               ;MOV THE DATA
        STI                                 ;REENABLE INTERRUPTS
        XOR     AX,AX                       ;ZERO 'AX'
        POP     SI                          ;MOVE 'EM OUT
        POP     DI
        POP     DS
        POP     ES
        POP     BP
        RET                                 ;RETURN TO CALLER
SWAPPG_PROC     ENDP
;
;       name:  setread(buffer beginning adrs, buffer ending adrs)
;       version:  1.0
;  This routine initializes the interrupt vector table in the IBM lower
;memory, sets up the async. card for interrupt on character receipt,
```

```
;sets the interrupt mask on the 8259, and establishes the addresses for
;the product receipt buffer (buf[]) and product received flag
;(prodflg).  Buf[] and prodflg are externs defined in 'C'.
;
        IF S_MODEL OR D_MODEL
SETREAD_PROC    PROC    NEAR
        ELSE
SETREAD_PROC    PROC    FAR
        ENDIF

; DEFINE THE INTERRUPT VECTOR AND PORT I/O ADDRESSES
        VALU    EQU     0CH                     ;PRIMARY CARD TYPE
        PORT    EQU     3F8H                    ;CARD I/O ADDRESS

; DEFINE THE PRODUCT HEADER AND TRAILER
        SOH     EQU     01H                     ;START OF TEXT
        ETX     EQU     03H                     ;END OF TEXT

SETREAD:
        PUSH    BP                              ;SAVE THE BASE
        MOV     BP,SP
        PUSH    DI
        PUSH    ES
        MOV     AX,FIRST_PARAM[BP]              ;GET OFFSET
        MOV     BUF0,AX                         ;SAVE OFFSET
        MOV     PTR0,AX                         ;INIT POINTER
      IF D_MODEL OR L_MODEL
        MOV     AX,SECOND_PARAM[BP]             ;GET THE SEGMENT
      ELSE
        MOV     AX,DS                           ;SAME AS CURRENT SEG
      ENDIF
        MOV     BUF0SEG,AX                      ;SAVE THE SEG
      IF S_MODEL OR P_MODEL                     ;GET BUFFER ENDING LOC
        MOV     AX,SECOND_PARAM[BP]
      ELSE
        MOV     AX,THIRD_PARAM[BP]
      ENDIF
        MOV     BUF0MAX,AX                      ;SAVE THE BUF END

; INITIALIZE THE INTERRUPTS
        MOV     DX,PORT                         ;GET I/O ADRS
        ADD     DX,3                            ;CALC REGISTER ADRS
        IN      AL,DX                           ;RETRIEVE LINE STATUS
        AND     AL,07FH
        OUT     DX,AL                           ;DLAB = 0
        SUB     DX,2
        IN      AL,DX                           ;GET CURRENT INTERRUPTS
        OR      AL,01                           ;SET THE DATA AVAILABLE
        OUT     DX,AL                           ;...INTERRUPT
        ADD     DX,3                            ;MODEM CONTROL REG
        MOV     AL,08H                          ;SETUP AL
        OUT     DX,AL                           ;CLEAR MODEM CONTROL

; INITIALIZE THE SYSTEM INTERRUPT CONTROLLER (8259) AND TABLE
        XOR     AX,AX                           ;ZERO AX
        MOV     ES,AX                           ;POINT AT INT TABLE
        MOV     DI,VALU * 4                     ;INT LOCATION
        MOV     AX,OFFSET INTERRPT              ;GET INTERRPT OFFSET
        CLD                                     ;STRING FORWARD DIR
        STOSW                                   ;STORE OFFSET ADRS
```

```
        MOV     AX,CS                   ;GET THE SEGMENT
        STOSW                           ;TABLE ENTRY COMPLETE
        IN      AL,21H                  ;GET THE INT MASK
      IF VALU EQ 0CH                    ;PRIMARY PORT
        AND     AL,0EFH
      ELSE
        AND     AL,0F7H                 ;SECONDARY
      ENDIF
        CLI                             ;DISABLE INTERRUPTS
        OUT     21H,AL                  ;SET ASYNC INT
        STI                             ;ENABLE INTERRUPTS
        POP     ES
        POP     DI
        POP     BP
        RET                             ;RETURN TO CALLER
;
; INTERRUPT SERVICE ROUTINE
; REGISTERS USED ARE:
;       AX - CONTAINS THE INPUT CHAR
;       BX - CONTAINS THE BUFFER OFFSET (BUF[])
;       CX - VARIABLE
;       DX - THE I/O PORT ADDRESS
;       DS - DATA SEGMENT FOR MEMORY ADRS USED IN THIS ROUTINE
;       ES - DATA SEGMENT OF THE BUFFER (BUF[])
INTERRPT:
        PUSH    ES                      ;STACK REGISTERS USED
        PUSH    DS
        PUSH    AX
        PUSH    BX
        PUSH    CX
        PUSH    DX
        MOV     DX,PORT                 ;SETUP PORT I/O ADRS
        IN      AL,DX                   ;READ CHAR
        ADD     DX,5                    ;LINE STATUS ADRS
        PUSH    AX                      ;SAVE CHAR
        IN      AL,DX                   ;READ LINE STATUS
        AND     AL,017H                 ;ISOLATE ERROR BITS
        POP     AX                      ;RESTORE CHAR
        JZ      SKIP1                   ;ERROR?
        MOV     AL,'?'                  ;REPLACE DATA WITH '?'
SKIP1:                                  ;NO ERROR, CONTINUE ON
        MOV     BX,SEG PTR0             ;GET THE PTR SEG
        MOV     DS,BX                   ;SETUP DS ADRSING
        MOV     BX,BUF0SEG              ;RETRIEVE BUF SEG
        MOV     ES,BX                   ;SETUP ES FOR BUF
        MOV     BX,PTR0                 ;GET CURRENT OFFSET
        MOV     ES:[BX],AL              ;PUT THE CHAR IN BUF
        INC     BX                      ;INCREMENT POINTER
        MOV     CX,BUF0MAX              ;GET THE BUF END OFFSET
        CMP     BX,CX                   ;AT THE BUFFER END?
        JB      SKIP2                   ;NO - CONTINUE ON
        MOV     BX,BUF0                 ;YES - RESET PTR
SKIP2:
        MOV     PTR0,BX                 ;UPDATE IN MEMORY
        CMP     AL,SOH                  ;BEGINNING OF PROD?
        JZ      BEGIN
        CMP     AL,ETX                  ;END OF PROD?
        JZ      FINISHED
RETURN:
        CLI                             ;DISABLE INTERRUPTS
```

```
        MOV     AL,20H                          ;CLEAR INTERRUPT
        OUT     20H,AL
        POP     DX
        POP     CX                              ;CLEAR STACK
        POP     BX
        POP     AX
        POP     DS
        POP     ES
        IRET                                    ;RESUME
BEGIN:                                          ;START OF A NEW PROD
        MOV     CX,BUF0                         ;GET THE BUF BEGINNING
        SUB     BX,CX                           ;CALC ARRAY ELEMENT + 1
        MOV     BEGIN0,BX                       ;SAVE STARTING ELEMENT
        JMP     RETURN
FINISHED:                                       ;END OF PRODUCT
        MOV     AX,BEGIN0                       ;GET STARTING ELEMENT
        XOR     CX,CX                           ;CLEAR 'CX'
        MOV     BEGIN0,CX                       ;CLEAR BEGINNING INDICE
        CMP     AX,00H                          ;VALID PROD START?
        JZ      RETURN                          ;IF NOT, FLUSH TRASH
        MOV     BX,SEG PRODFLG                  ;LOAD PRODFLG SEG
        MOV     DS,BX                           ;DS IS NOW PRODFLG SEG
        MOV     BX,OFFSET PRODFLG               ;ACTUAL PRODFLG ADRS
        MOV     [BX],AX                         ;SET THE PRODFLG FLG...
                                                ;WITH LOC OF ARRAY + 1
        JMP     RETURN
SETREAD_PROC    ENDP
;
;
;       name:   setstat()
;       version:  1.0
;  This routine sets up an asynchronous card for modem status interrupt
;to trigger the speaking routine.  Interrupts are reenabled upon
;entering this routine, but all product decoding and user interaction
;is halted.

        IF S_MODEL OR D_MODEL
        EXTRN   TRANSMIT:NEAR           ;BROADCAST ROUTINE
SETSTAT_PROC    PROC    NEAR
        ELSE
SETSTAT_PROC    PROC    FAR
        ENDIF

; DEFINE THE INTERRUPT VECTOR AND PORT I/O ADDRESS
        VALU    EQU     0BH             ;INTERRUPT VECTOR ADRS
        PORT    EQU     2F8H            ;SECONDARY PORT I/O ADRS

SETSTAT:
        PUSH    BP                      ;STACK 'EM
        MOV     BP,SP
        PUSH    ES
        PUSH    DI
        MOV     BASE,DS                 ;SAVE BASE SEG ADRS
        MOV     EXTRA,ES                ;SAVE EXTRA SEG
        MOV     DX,PORT + 3             ;RETRIEVE PORT ADRS
        IN      AL,DX
        AND     AL,07FH                 ;CLEAR DLAB BIT
        OUT     DX,AL                   ;DLAB = 0
        MOV     DX,PORT + 4             ;MODEM CONTROL ADRS
        MOV     AL,0AH                  ;SET RTS AND OUT2
```

```
          OUT     DX,AL
          MOV     DX,PORT + 1             ;LINE CONTROL ADRS
          MOV     AL,08H                  ;ENABLE MODEM STATUS INT
          OUT     DX,AL

; SETUP THE INTERRUPT TABLE AND ENABLE SYSTEM INTERRUPTS
          XOR     AX,AX                   ;CLEAR AX
          MOV     ES,AX                   ;VECTOR TABLE SEGMENT
          MOV     DI,VALU * 4             ;TABLE OFFSET
          MOV     AX,OFFSET TALK          ;GET INT ROUTINE OFFSET
          CLD                             ;STORE DIRECTION
          STOSW                           ;OFFSET IN PLACE
          MOV     AX,CS                   ;GET INT ROUTINE CODE SEG
          STOSW                           ;TABLE ENTRY COMPLETE
          MOV     DX,PORT + 6             ;GET MODEM STATUS REGISTER
          IN      AL,DX                   ;CLEAR ANY POSSIBLE INT
          IN      AL,21H                  ;GET THE CURRENT INTERRUPTS
        IF VALU EQ 0CH                    ;PRIMARY CARD?
          AND     AL,0EFH                 ;SET INTERRUPT BIT
        ELSE                              ;SECONDARY?
          AND     AL,0F7H
        ENDIF
          CLI                             ;STOP SYSTEM INTERRUPTS
          OUT     21H,AL                  ;ENABLE OUR INTERRUPT
          STI                             ;LET THE SYSTEM RESUME
          POP     DI                      ;MOVE 'EM OUT
          POP     ES
          POP     BP
          RET                             ;RETURN TO CALLER
;
; INTERRUPT SERVICE ROUTINE FOR SPEAKING
TALK:
          PUSH    BP                      ;STACK 'EM
          PUSH    DS
          PUSH    ES
          PUSH    DI
          PUSH    SI
          PUSH    AX
          PUSH    BX
          PUSH    CX
          PUSH    DX
          MOV     DX,PORT + 1             ;INT ENABLE REGISTER
          MOV     AL,00H                  ;REMOVE INT SOURCE
          OUT     DX,AL
          MOV     DX,PORT + 6             ;MODEM STATUS PORT ADRS
          IN      AL,DX                   ;CLEAR ASYNC CARD INT
          STI                             ;ENABLE INTERRUPTS
          MOV     AX,SEG BASE             ;GET THE SEG OF BASE VARIABLE
          MOV     DS,AX
          MOV     AX,EXTRA                ;RESTORE 'ES'
          MOV     ES,AX
          MOV     AX,BASE                 ;RESTORE 'DS'
          MOV     DS,AX
          CALL    TRANSMIT                ;BROADCAST THE PRODUCT
          MOV     DX,PORT + 6
          IN      AL,DX                   ;CLEAR ANY EXTRANEOUS INT
          MOV     DX,PORT + 1             ;INT ENABLE REGISTER
          MOV     AL,08H                  ;MODEM STATUS INT
          OUT     DX,AL                   ;REENABLE ASYNC INT
          CLI                             ;TURN INTERRUPTS OFF
```

```
        MOV     AL,20H                  ;RETURN FROM INTERRUPT
        OUT     20H,AL
        POP     DX                      ;RETURN TO PREVIOUS TASK
        POP     CX
        POP     BX
        POP     AX
        POP     SI
        POP     DI
        POP     ES
        POP     DS
        POP     BP
        IRET                            ;RESUME PREVIOUS TASK
SETSTAT_PROC    ENDP
;
;       name:  reset()
;       version:  1.0
;  This routine disables the interrupts from the async cards.

        IF S_MODEL OR D_MODEL
RESET_PROC      PROC    NEAR
        ELSE
RESET_PROC      PROC    FAR
        ENDIF

RESET:
        IN      AL,21H                  ;GET THE CURRENT INT ENABLED
        OR      AL,18H                  ;RESET ASYNC
        CLI                             ;DISABLE INTERRUPTS
        OUT     21H,AL                  ;REMOVE ASYNC INT
        STI                             ;REENABLE SYSTEM
        XOR     AH,AH                   ;CLEAR HIGH AX
        RET                             ;RETURN TO CALLER
RESET_PROC      ENDP



;
;*****************************************************************
; end the appropriate segment
        IF      S_MODEL
PROG    ENDS
        ENDIF

        IF      P_MODEL
_CODE   ENDS
        ENDIF

        IF      D_MODEL
CODE    ENDS
        ENDIF

        IF      L_MODEL
_PROG   ENDS
        ENDIF

        END                     ;(END OF FILE)
```

C. Transmit.c

The transmit.c file contains two functions which maintain the broadcast on the NWR console. These routines are: fetch and transmit. Fetch moves the voice data from disk to memory, and organizes these data into the proper format.. Transmit manages the memory buffers containing the voice data, "speaks" the voice phrases and starts the next tape deck on the NWR console when the voice product is finished. The transmit routines are started from talk (setstat in func.asm) via a modem signal (DTR) change generated from the NWR console.

transmit.c

```
/*      date:  May 1985
        version:  1.0
        by:  Glen W. Sampson

Purpose:
  These routines maintain the broadcast to the NWR console.

Exit:
  The only possible exit from this program is if an error occurs while
trying to read the voice data from disk.

Created by:
        (Version 2.14 of Lattice C)
        C>lc1 transmit -mD
        C>lc2 transmit -v
*/

#include "define.c"                     /* parameters */
extern struct pgmidx {                  /* global variables */
        int pg_fd;
        int pg_high;
        int pg_low;
        unsigned int pg_length;
} pgm[pgmphr + 1];
extern char *ptr1;
extern char *ptr2;

/*****  name:  FETCH(N, PTR)
This routine fills the preallocated memory buffer with voice data,
retrieves the voice data from disk and returns the starting memory adrs
of this voice data.  Phrase N is retrieved from the program array, and
PTR contains the memory buffer address.
global variables used:
        struct pgmidx           /* program catalog */
        char header[]           /* phrase header */
routine callers:
        transmit()
*/
char *fetch(n, ptr)
int n;                          /* phr to get frm pgm catalog */
char *ptr;
{
        int status;                     /* status of an operation */
        int j;                          /* general purpose counter */
        long i;                         /* ...ditto */

/*  setup disk and read in the voice data  */
        status = Dseek(pgm[n].pg_fd, pgm[n].pg_low, pgm[n].pg_high, 0);
        status = Dread(pgm[n].pg_fd, pgm[n].pg_length, &ptr[9]);
        if (status == ERROR)
                fatal("Phrase data disk error\n");

/*  put a header and trailer on voice data  */
        i = pgm[n].pg_length + 91;
        for (j = 4; j > 0; j--)                 /* install trailer */
                ptr[i++] = 0;
        movmem (&pgm[n].pg_length, &ptr[7], (unsigned)2);

        return(ptr);                            /* rtn memory adrs */
}
```

```
/*****  name:  TRANSMIT()
This function is called when a request is received from the console to
broadcast a message.  All other polled procedures are halted during
broadcast.
routine callers:
        talk                        ;interrupt service routine
global variables used:
        struct pgm                  ;program table
*/
transmit()
{
char *ptr;                          /* memory pointer from fetch() */
char *fetch();                      /* function returning a ptr */
int i;                              /* general purpose counter */
int status;                         /* Vynet status retrieval word */

/* transmit a message */
        Delay(outchn,1);                    /* delay 16 milliseconds */
        printf("\nnow transmitting\n");
        ptr = fetch(0, ptr1);               /* put phr in memory */
        Speak(outchn, 1, ptr);              /* speak first phrase */
        for (i = 1; pgm[i].pg_fd >= 0; i++) {
                if (i % 2)
                        ptr = fetch(i, ptr2);    /* second buffer */
                else
                        ptr = fetch(i, ptr1);    /* first buffer */
                while ((status = ChkStat(outchn)) == WAITING);
                Speak(outchn, 1, ptr);           /* speak next phrase */
        }
        while ((status = ChkStat(outchn)) == WAITING);  /* finished? */
        printf("done transmitting\n");
        outp(764,8);                        /* lower the RTS */
        Delay(outchn, 10);                  /* delay about 1 sec */
        while ((status = ChkStat(outchn)) == WAITING);  /* pause */
        outp(764,10);                       /* raise RTS */
        return;                             /* return to caller */
}
```

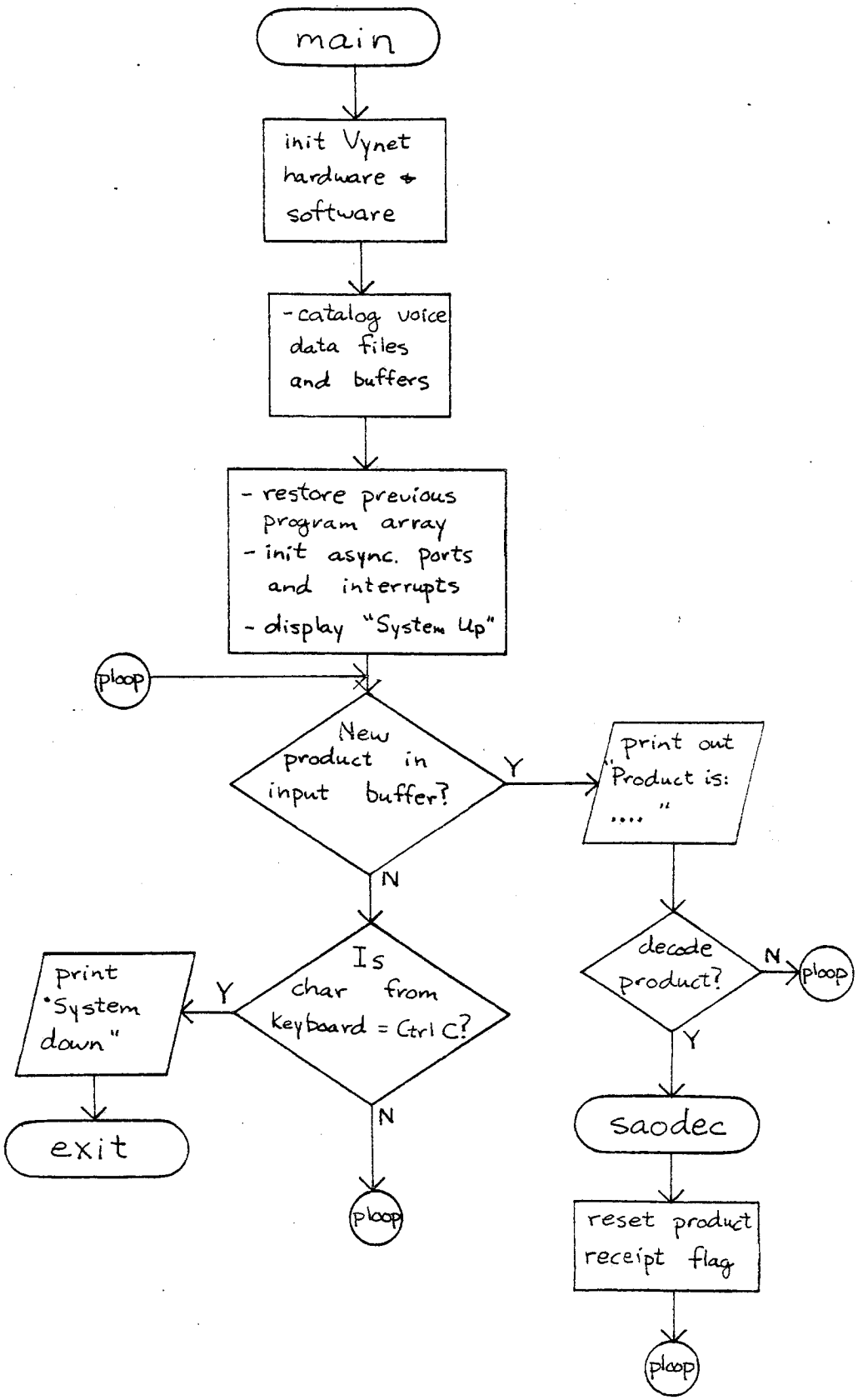
D. Disk File Descriptions and Formats

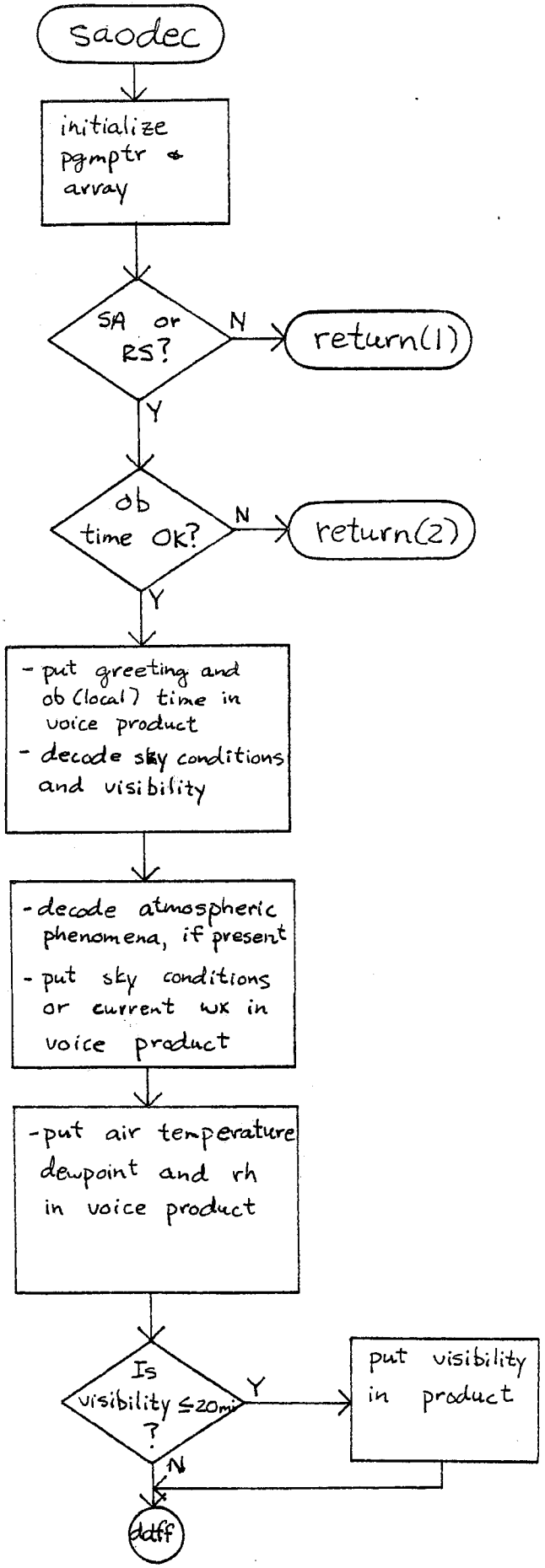
The following is a list of disk files used by the voice synthesis system with a description of its purpose and format:

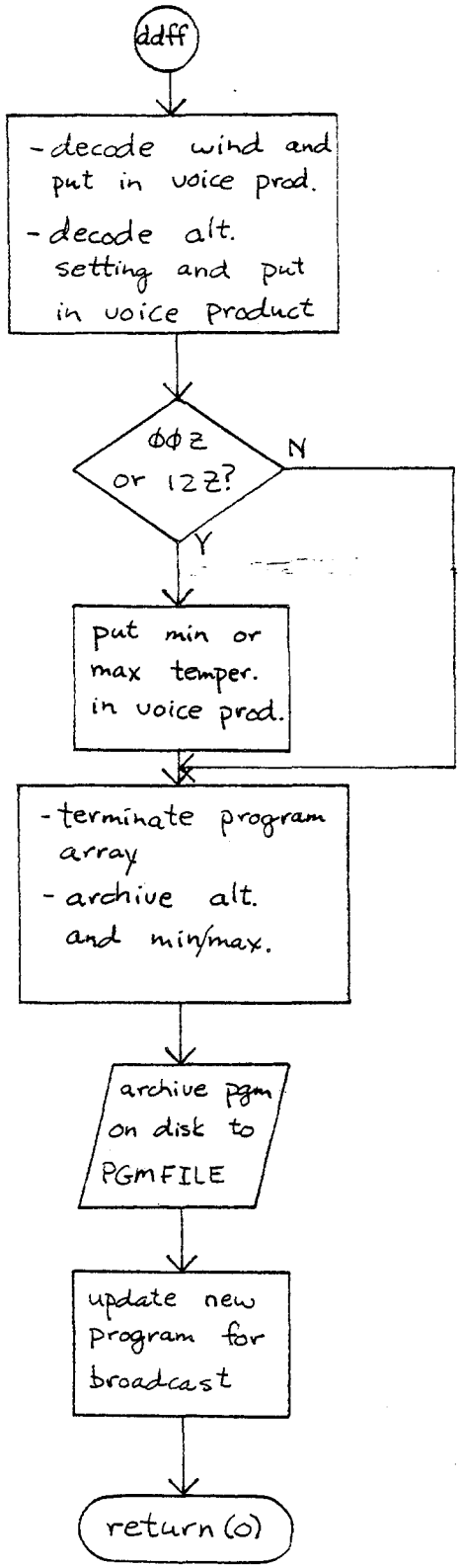
1. sao_vd.idx - This file contains the index of voice phrases used to generate the voice product. Sao_vd.* is created by the Vynet utility program Digitize, which records and edits the voice input phrase onto the disk. The format is described in the Vynet User's Guide in Section 9 and is: phrase number, 2 bytes; phrase offset, 4 bytes; and, phrase length, 2 bytes.

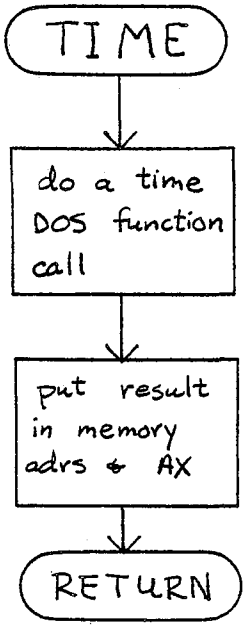
2. sao_vd.phs - This file is the complement of sao_vd.idx and contains the actual voice data indexed by the *.idx file. This data is essentially the mathematical representation (ADPCM in voice synthesis lingo) of the analog voice input. Again sao_vd.phs is created by using the Vynet Digitize program. The format of this file is: header, 2 bytes; and up to 64534 bytes of data.

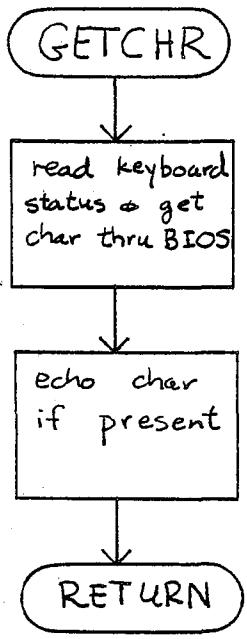
3. pgmfile - The last observation successfully encoded into a voice product has its phrase indexes stored in pgmfile. The purpose of this file is to enable restoration of the voice product if the system crashes or is taken down for a period of time. The format of pgmfile is: file handle of *.phs file, 2 bytes; phrase offset, 4 bytes; and, phrase length, 2 bytes. The file handle is a static number, since only one voice product is currently being generated. If additional voice products are generated, the file handle should become a dynamically assigned number to avoid an erronous file handle assignment.

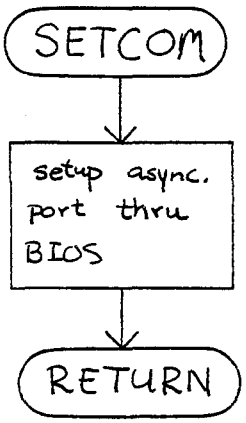

main
init Vynet hardware & software
- catalog voice data files and buffers
- restore previous program array
- init async. ports and interrupts
- display "System Up"
ploop
New product in input buffer?
Y
print out "Product is: .... "
N
decode product?
N
ploop
Y
saodec
reset product receipt flag
ploop
Is char from keyboard = Ctrl C?
Y
print "System down"
exit
N
ploop

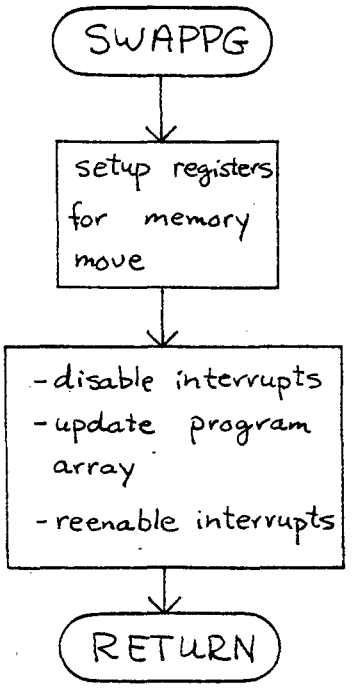

saodec
initialize pgmptr & array
SA or RS?
N
return(1)
Y
ob time OK?
N
return(2)
Y
- put greeting and ob (local) time in voice product
- decode sky conditions and visibility
- decode atmospheric phenomena, if present
- put sky conditions or current wx in voice product
- put air temperature dewpoint and rh in voice product
Is visibility ≤20mi ?
Y
put visibility in product
N
dtff

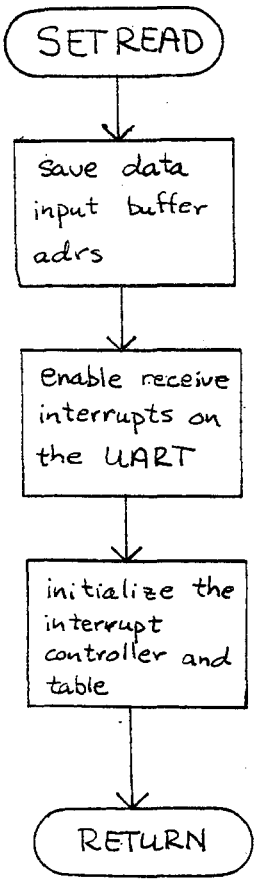

ddff
- decode wind and put in voice prod.
- decode alt. setting and put in voice product
ΦΦ2 or 122?
N
Y
put min or max temper. in voice prod.
- terminate program array
- archive alt. and min/max.
archive pgm on disk to PGMFILE
update new program for broadcast
return (0)

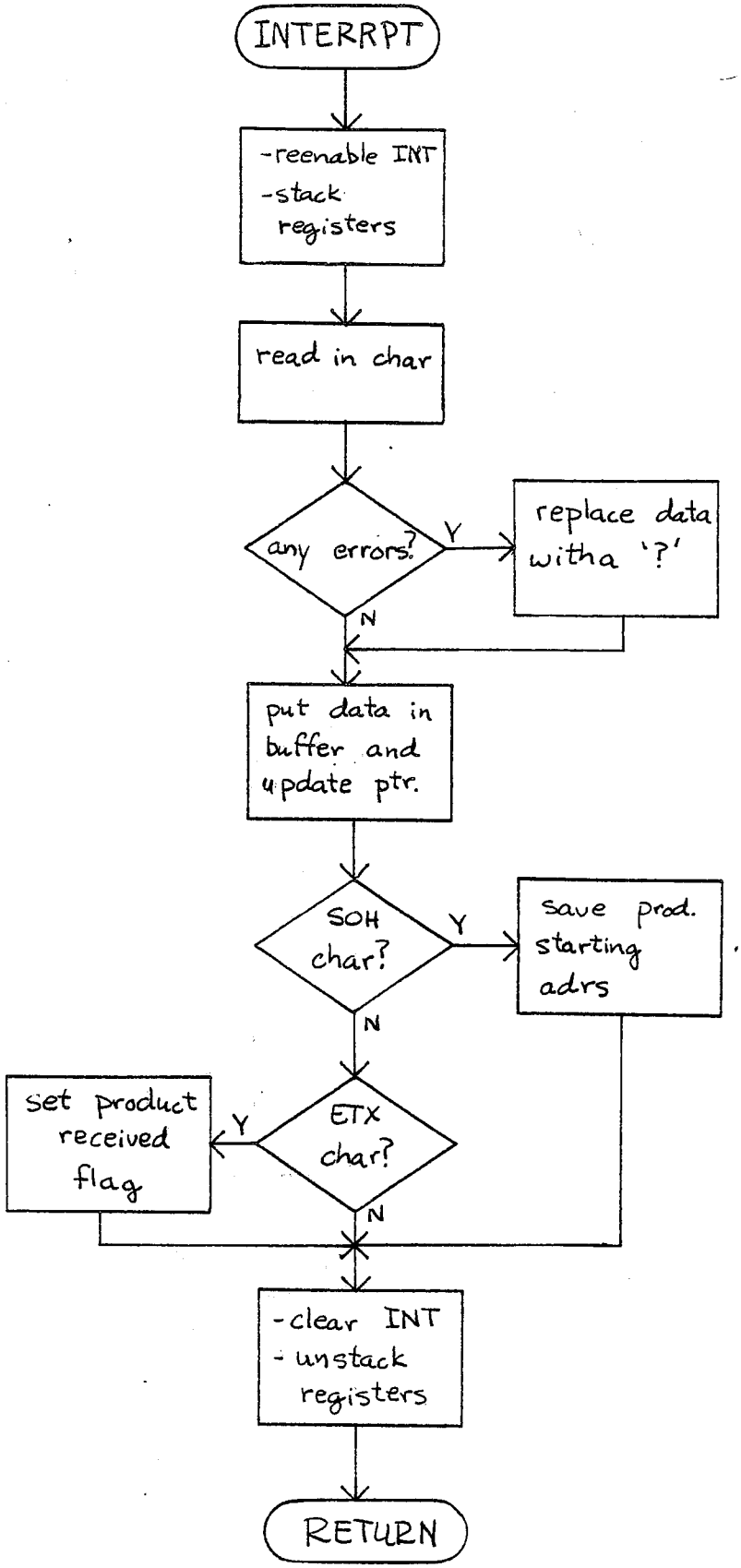

TIME
do a time DOS function call
put result in memory adrs & AX
RETURN

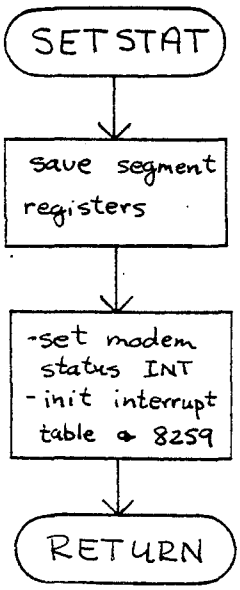

GETCHR
read keyboard status & get char thru BIOS
echo char if present
RETURN

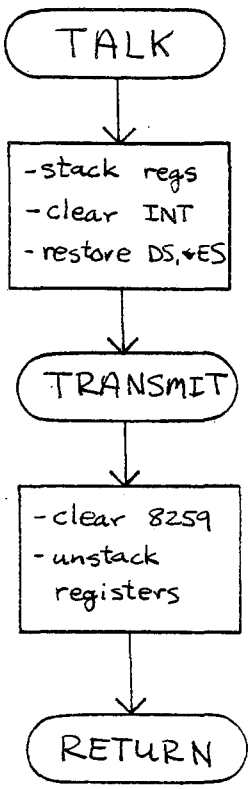

SETCOM
setup async. port thru BIOS
RETURN

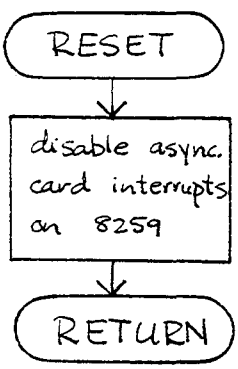

SWAPPG
setup registers for memory move
-disable interrupts
-update program array
-reenable interrupts
RETURN

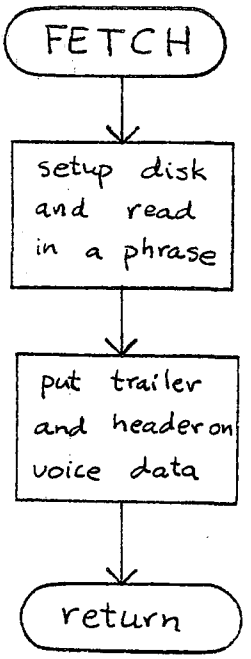

SETREAD
save data input buffer adrs
enable receive interrupts on the UART
initialize the interrupt controller and table
RETURN

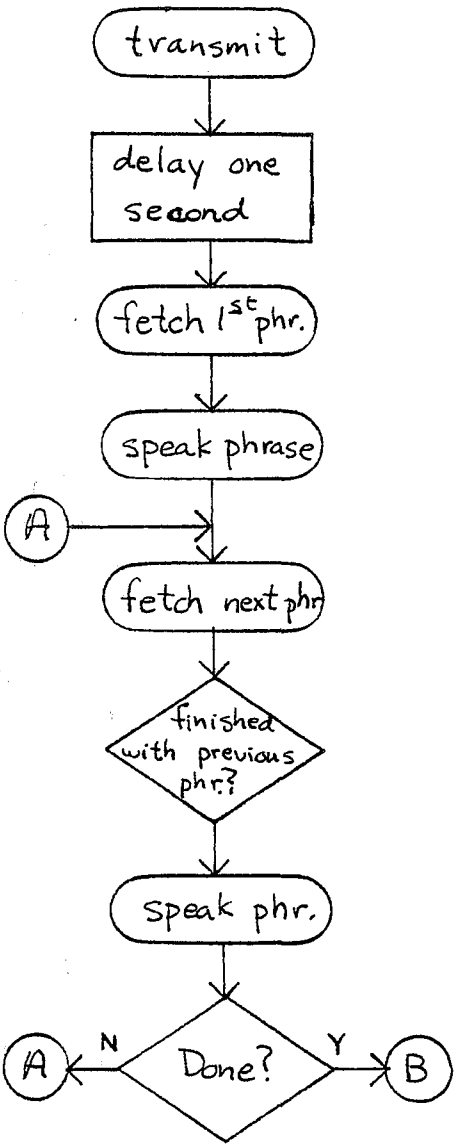

INTERRPT
-reenable INT
-stack registers
read in char
any errors?
Y
replace data witha '?'
N
put data in buffer and update ptr.
SOH char?
Y
save prod. starting adrs
N
ETX char?
Y
set product received flag
N
-clear INT
-unstack registers
RETURN

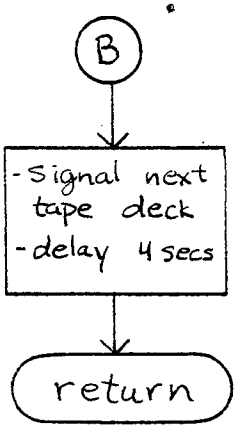

SETSTAT
save segment registers
-set modem status INT
-init interrupt table & 8259
RETURN


TALK
-stack regs
-clear INT
-restore DS, ES
TRANSMIT
-clear 8259
-unstack registers
RETURN


RESET
disable async. card interrupts on 8259
RETURN


FETCH
setup disk and read in a phrase
put trailer and header on voice data
return


transmit
delay one second
fetch 1st phr.
speak phrase
A
fetch next phr
finished with previous phr.?
speak phr.
A
N
Done?
Y
B


B
- signal next tape deck
- delay 4 secs
return

Appendix A - Vocabulary List for Surface Observations

Phrase: Listed below.

Offset: 110

Title: greet

1. Good morning.
2. Good afternoon.
3. Good evening.

Phrase: Current weather conditions at (time) at the Salt Lake Airport. We have (current weather).

Offset: 113

Title: curwx

1. Current weather conditions at _____
2. at the Salt Lake Airport. We have _____
3. midnight
4. a.m.
5. noon
6. p.m.
7. sunny skies.
8. clear skies.
9. mostly sunny skies.
10. mostly clear skies.
11. partly cloudy skies.
12. mostly cloudy skies.
13. cloudy skies.
14. fog.
15. fog and _____.
16. rain.
17. rain and _____.
18. rain showers.
19. rain showers and _____.
20. smoke.
21. smoke and _____.
22. haze.
23. haze and _____.
24. lightening.
25. lightening and _____.
26. a thunderstorm.
27. a thunderstorm with _____.
28. heavy _____.
29. light _____.
30. freezing rain.
31. drizzle.
32. freezing drizzle.
33. ice pellets.
34. snow.
35. snow showers.
36. snow pellets.
37. snow grains.
38. ice crystals.
39. hail.
40. ground fog.
41. blowing snow.
42. blowing sand.
43. blowing dust.
44. ice fog.
45. dust.
46. blowing spray.

Phrase: Visibility, (distance) miles.

Offset: 159

Title: vis

1. Visibility, _____
2. _____ miles.
3. _____ of a mile.
4. one sixteenth (of a mile).
5. one eighth (of a mile).
6. three sixteenths (of a mile).
7. one quarter (of a mile).
8. five sixteenths (of a mile).
9. three eighths (of a mile).
10. one half (of a mile).
11. five eighths (of a mile).
12. three quarters (of a mile).
13. seven eighths (of a mile).
14. one mile.
15. one and _____.
16. two and _____.

Phrase: Temperature, (value) degrees.
Dewpoint, (value) degrees.
Relative humidity, (value) percent.

Offset: 175

Title: temp

1. Temperature, _____
2. one degree.
3. _____ degrees.
4. Dewpoint, _____
5. Relative humidity, _____
6. _____ percent.
7. The lowest temperature recorded so far this morning was _____.
8. The highest temperature recorded so far today was _____.
9. one degree below zero.
10. _____ degrees below zero.

Phrase: Winds are from the (direction at) (speed) miles an hour, gusting to (speed).

Offset: 185

Title: wind

1. (not used)
2. _____ miles an hour.
3. _____ miles and hour, gusting to _____.
4. Winds are from the north at _____
5. Winds are from the northeast at _____
6. Winds are from the east at _____
7. Winds are from the southeast at _____
8. Winds are from the south at _____
9. Winds are from the southwest at _____
10. Winds are from the west at _____
11. Winds are from the northwest at _____
12. Winds are calm.
13. Winds are light and variable.

Phrase: The barometer reads (value) point (value) inches, and is (tendency).

Offset: 198

Title: pressure

1. The barometer reads _____
2. _____ inches, and is falling.
3. _____ inches, and is steady.
4. _____ inches, and is rising.
5. _____ point _____

Phrase: none (insert the numbers into phrases)

Offset: ϕ

Title: numbers

1. 0
2. 1
3. 2
4. 3
5. 4
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