COMMON FORMAT FOR EXCHANGE OF SOLVED LOAD FLOW DATA

Working Group on a Common Format for Exchange of Solved Load Flow Data

ABSTRACT

This paper presents a Common Format for the exchange of solved load flow cases. This format is presently being used throughout most of the eastern and north central United States and parts of Canada. By publishing through the national organization, it is intended that a common reference be established and maintained for those who wish to use the format. The paper presents a detailed description of the format as well as procedures for making revisions and additions.

INTRODUCTION

With the growth in complexity of the interconnected power systems in the 1960's came a corresponding growth in the number of load flow programs being used and in the number of study groups using those programs. This growth resulted in a need to exchange data at an increasing rate. Among the many methods used to implement these exchanges, the more popular ones have been the use of listings and of card or tape in input format. The average load flow case of today has such a volume of data that the use of listings is not practical or desirable from an accuracy standpoint. The use of data in an input format is more satisfactory but may involve the development and maintenance of a number of programs to convert data from a variety of sources. A more practical and desirable method is the use of an agreed-upon Common Format to transmit the data from a solved load flow case. Only a single conversion package is needed by each of the participants. An additional advantage in exchanging solved case data is that it enables the recipient to compute equivalents of neighboring systems without the need for a large load flow program.

Historical

In 1968, the MIIO (Michigan-Illinois-Indiana-Ohio) Transmission Studies Task Force, with representation from Ontario Hydro, set about to establish a common format. This group was subsequently expanded to include representatives from ECAR, MAIN, NPCC, General Electric and Westinghouse. A Common Format for exchange of solved load flow data was adopted by this group in 1969. This format was subsequently adopted by MAAC, McDonnell Douglas, Control Data and Stone & Webster. The first manual was prepared in November 1969 and widely circulated throughout the central and northeastern United States. A revised manual ("Common Format for Exchange of Solved Load Flow Data") was issued in November 1971.

In 1971, the Working Group for the Exchange of Solved Load Flow Data was formed as a joint working group under the System Planning Subcommittee and the Computer and Analytical Methods Subcommittee, both in the Power System Engineering Committee. The purpose of this working group is to publish the Common Format for the exchange of solved load flow data as presented in the November 1971 manual. In addition, it will act as a central body to handle any future revisions and additions.

Members of the Working Group on a Common Format for Exchange of Solved Load Flow Data of the Power Systems Engineering Committee are: H. E. Pierce, Jr., Chairman, H. W. Colborn, D. W. Coleman, E. A. Marriage, J. C. Richard, L. J. Rindt, L. J. Rubino, G. W. Stagg, T. P. Traub, J. Vandergrift, C. E. Winn, C. C. Young.

Revisions And Additions

Suggestions for revisions to the Common Format should be sent to the Chairman of the IEEE Working Group on Common Format for the Exchange of Solved Load Flow Data, whose name and address are available in the Power Engineering Society Organization Manual. The Chairman will forward the suggestion to the Working Group members. It will be the responsibility of the Working Group members to review these changes with major users. Acceptance or rejection of the suggested changes will be accomplished by mail or at the next Working Group meeting. If a minor revision is approved by the Working Group, notification will be given in the Power Engineering Society Newsletter and, if required, in the Spectrum. If a major revision is required, full republication will be pursued.

It is expected that changes will develop in requirements for transfer of solved load flow data in the future. The Working Group will keep abreast of these changes and, when it appears that sufficient need exists, will incorporate them into the Common Format. Examples could be a developing need for load flow study of dc links or for exchanging change case data.

MECHANICS OF TRANSFER

Normally the load flow data will be exchanged on a magnetic tape. However, to cover the situations where the recipient is unable to read tapes, it is desirable that the sender be prepared to send cards.

The magnetic tape will normally be supplied by the recipient. The number of tracks and density will be ne-

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gotiable items to be resolved by the two parties exchanging the tape. However, certain characteristics of the tape must be standard, and these characteristics are listed below:

1. BCD or EBCDIC
2. Fixed-length logical records of 132 characters
3. Unblocked records
4. No tape label record
5. No carriage control characters
6. No blank records

The tape must be rewound to its load point before writing, and only one case should be written on it unless the recipient has agreed to accept more than one case per tape. It is strongly recommended that the following information be provided with the tape:

1. A letter of transmittal which contains the case title, a description of the system conditions that the load flow represents, a total count of buses and branches, and any information that is not included in the load flow data being transferred such as:
   a. DC line data
   b. Variation of transformer impedance as a function of tap or phase angle position
   c. Switched capacitors
   d. Bus types other than those described under "Bus Data"
2. A copy of the load flow printout with data dump
3. A copy of the listing of the common format tape
4. A completed copy of the standard form shown in Figure 1.

TAPE FORMAT OF THE LOAD FLOW DATA

Character Length

The logical records have been restricted to a maximum of 132 characters so that a single line listing, record by record, can readily be obtained by the recipient. The records, which are longer than 80 characters, have been written so that they could be easily punched on two cards.

Case Identification

The first record contains an identification of the load flow data being transferred. This record acts as a tape label as is shown in Figure 2.

End Of Data

The last record on the tape before the end-of-file mark must be the "END OF DATA" record.

Headers And Delimiters

Each of the data groups must be preceded by a header record and terminated by a delimiter record. The header record lists the number of items in that particular group which can be checked against the sequence number. (The header and delimiter must not be included in the count of items.) If there is no data to be entered for a group, the header and delimiter for that group must be entered and the header must state that there are zero items.

The description e.g. "BUS DATA FOLLOWS," the number of items and the word "ITEMS" must be present as in Figure 3.

Sequence Numbers

Each record in a data group (bus data, branch data, etc.) must have a sequence number (characters 129-132)

```
                COMMON FORMAT DATA EXCHANGE

SENDING COMPANY - ______________________________
CASE NAME - ____________________________________
IF DATA PROBLEMS OCCUR, CONTACT:
    NAME: _________________________
    DEPT: _________________________
    PHONE: ________________________
IF TAPE READING PROBLEMS OCCUR, CONTACT:
    NAME: _________________________
    DEPT: _________________________
    PHONE: ________________________
TAPE CHARACTERISTICS:
    TAPE IDENTIFICATION NO. __________
    RECORDS
       BLOCKING - UNBLOCKED
       CHARACTERS - 132
       LENGTH - FIXED
       TAPE LABEL - NONE
    CARRIAGE CONTROL CHARACTERS - NONE
    BCD __________, EBCDIC ________
    TRACKS: 7 ______, 9 ________
    PARITY: EVEN _________, ODD ________
    DENSITY: 800 BPI ________, 1600 BPI ______
    PHYSICAL RECORD LENGTH: _______ CHARACTERS
```

Figure 1.

to allow verification that all the records were written. The sequence numbers in each group must start at 1 and be incremented by 1 for each item up to NNNN. The total number of items in that group is entered as part of the header record. When the number of items becomes greater than 9999, the numbering sequence will be restarted at 0000.

Sequence numbers must not be used on the case identification record, the end of data record, or any of the headers or delimiters.

CARD FORMAT FOR LOAD FLOW DATA

The data being supplied in card format is identical to that being supplied on tape. However, the design of the card format provides for the data to be punched on one or two cards. The correspondence between the location of card and tape data is shown in Table I.

TABLE I

Card - Tape Correspondence

Tape Columns	Card Columns
1 - 75	1 - 75 (first card)
76 - 128	1 - 53 (second card)

Card columns 76-80 are to be used for sequence numbers. Enter in columns 77-80 the 4 character sequence

1	2	10	31	38	43–44	45 … 131–132
D	DATE D MM YY	SENDER'S NAME OR IDENTIFICATION	MVA BASE	YEAR	S/W	30 CHARACTER CASE IDENTIFICATION
0	5/01/71	ØNTARIØ HYDRØ	100.0	1976	S	LF 100-1976 BASE CASE
				OR		
0	/0/0	0	100.0	0	0	0

Figure 2. Title Data

number as used on the tape. Enter in column 76 an alphabetic character as given below:

A - first bus card
B - second bus card
C - first branch card
D - second branch card
E - loss zone cards
F - interchange cards
G - tie line cards

Where the data is contained on two cards as in the case of buses and transformers, the same sequence number must be punched on both cards. The alphabetic code in column 76 indicates which is the first card and which is the second one.

Provide only the first branch card for transmission lines since all the data is contained on this card. However, two branch cards must be provided for transformers and phase shifters.

DATA PREPARATION

General Comments

No alpha-numeric field (bus name, area name, etc.) should contain any special characters since they vary from computer to computer. The following is a list of these special characters:

:	+	(	$
;	=	)	%
?	≠	[	#
!	>	]	Δ
'	<	\	
&	@		

Imbedded blanks in an alpha-numeric field are acceptable.

Any item listed in the format that is not available in a user's load flow program must be entered as a zero (0 - integer and alpha-numeric; 0.0 - floating point) rather than left blank. A blank will be interpreted as an item that was overlooked. For alpha-numeric fields the zero must be entered in the left most position. Note: Exceptions to this statement are the data supplied for transformers, phase shifters and interchange schedules. In these data, certain quantities not specifically available must be generated and supplied.

Isolated buses and outaged lines (represented by zero impedance) must not be transmitted on the common format tape, even though these data are contained on some load flow history tapes.

1	2	3–5	6	18	24	27	34	41	50	60	68	74	75
B	U	S	DATA FOLLOWS					NNNNN ITEMS (HEADER)					
B N	BUS NO.		BUS NAME (LEFT JUSTIFIED)	AREA	ZONE	TYPE	FINAL VOLTS PU.	FINAL ANGLE DEG.	LOAD MW	LOAD MVAR	GENERATION MW	GENERATION MVAR		
N	N	N N	AAAAAAAAAAAA	NN	NNN	NN	X.XXXX	±ØØØ.ØØ	±XXXXX.XX	±XXXXX.XX	±XXXXX.XX	± XXXX.	X	X
-	9	99	(DELIMITER)											

76	77	84	91	99	107	115	123	128	131	132
	BASE KV	DESIRED VOLTS PU.	MVAR OR VOLTAGE LIMITS MAX.	MIN.	RESISTORS REACTORS OR CAPACITORS G PU.	B PU.	REM. CONT. BUS NO.	SEQ. NO.		
X	XXX.XX	X.XXXX	±XXXX.XX	±XXXX.XX	±XX.XXXX	±XX.XXXX	NNNN	NN	N	N
			X.XXXX	X.XXXX						

Figure 3. Bus Data

Case Identification

The case identification should provide the following information:

1. date the common format tape was created
2. sender's name (20 characters)
3. Mva base (100. 0 or actual)
4. year and season of year which the case describes
5. case description or case number (30 characters)

Any additional information should be included in the letter of transmittal. Item 3, the Mva base, is mandatory whereas all the other items are optional. Where items are not supplied, a zero is entered as the first character of each field. Samples of a complete header and the optional header are illustrated in Figure 2.

Bus Data - Mandatory

The following data is mandatory for all types of buses and must be entered as outlined below and as shown in Figure 3. Samples of various ways of providing bus data are illustrated in Figure 4.

1. Bus Number (columns 1-4)

   A four digit integer from 1 to 9999. These numbers are the numbers used in the load flow case being transferred and, therefore, may not be consecutive. It is the responsibility of the recipient to renumber the buses if so desired.

2. Bus Name (columns 6-17)

   The bus name must be left justified with a maximum of 12 characters. The following format for bus names is suggested:

area	name	kV
--	--------	---

3. Bus Area (columns 19-20)

   A two digit integer from 1 to 99 indicating in which company or region the station is located. Area 0 must not be used as it is used to indicate unavailable data.

4. Final Voltage (columns 28-33)

   This is the final bus voltage in per unit as defined by the solved load flow case. It is not necessarily the same as the desired voltage.

5. Angle (columns 34-40)

   This is the final angle in degrees.

6. Load (columns 41-58)

1	2												74	75
	B N	US O.	BUS NAME (LEFT JUSTIFIED)	AREA	ZONE	TYPE	FINAL VOLTS PU.	FINAL ANGLE DEG.	LOAD MW	LOAD MVAR	GENERATION MW	GENERATION MVAR		
B	U	S	DATA FOLLOWS					8 ITEMS						
		31	02PØNTIAC345	2	1	0	1.0067	-24.45	0.0	0.0	0.0	0.	0	
		37	02RVRVIEW120	2	1	0	1.0364	-28.92	171.00	25.00	75.0	0.	0	0
		89	02GARFLD 138	2	2	2	0.9841	-26.11	136.70	72.40	0.00	30.	0	0
	1	25	02WEADK B230	2	2	2	1.0350	-19.69	68.10	32.00	285.00	91.	7	6
	1	42	03PINARD 230	3	0	2	1.0400	36.89	0.0	0.0	433.00	-38.	0	7
	1	43	03PINARD 500	3	0	0	1.0583	34.07	0.0	0.0	0.0	0.	0	
	2	39	04DRESDEN138	4	0	1	1.0300	-30.65	85.00	0.00	200.00	76.	0	0
	3	70	07SPORN 138	7	0	3	1.0350	0.00	607.00	203.00	644.31	99.	2	6
-	9	99												

76	77									131	132
		BASE KV	DESIRED VOLTS PU.	MVAR OR VOLTAGE LIMITS MAX	MIN	RESISTORS, REACTORS OR CAPACITORS G PU.	B PU.	REMOTE CONTROL BUS NO.	S N	E O	Q .
		0.0	0.0	0.0	0.0	0.0	0.0	0			1
		0.0	0.0	0.0	0.0	0.0	0.0	0			2
		0.0	0.9841	30.00	30.00	0.0	0.0350	0			3
		0.0	1.0350	138.00	0.00	0.0	0.0	0			4
		220.00	1.0583	300.00	-300.00	0.0	1.0470	143			5
		500.00	0.0	0.0	0.0	0.0	0.0	0			6
		0.0	0.0	1.0350	1.0250	0.0	0.0	0			7
		0.0	1.0350	0.0	0.0	0.0	0.0	0			8

NOTES
(1) BUSES 31, 37, 143 ARE UNREGULATED
(2) BUS 37 HAS FIXED GENERATION OF 75 + J0
(3) BUS 89 HAS FIXED GENERATION OF 0 + J30 BUT IS ENTERED AS REGULATED BUS
(4) BUS 89 HAS A 3.5 MVAR CAPACITOR
(5) BUSES 125 AND 142 ARE VOLTAGE REGULATED BUSES (TYPE 2)
(6) BUS 142 IS CONTROLLING THE VOLTAGE AT BUS 143
(7) BUS 239 IS A MVAR REGULATED BUS (TYPE 1)
(8) BUS 370 IS THE MASTER SWING BUS
(9) BUSES 31 AND 37 ARE IN ZONE 1 OF AREA 2
BUSES 89 AND 125 ARE IN ZONE 2 OF AREA 2

Figure 4. Representation of Bus Data

The Mw and Mvar station load or zeroes.

7. Generation (columns 59-75)

The final Mw and Mvar generation or zeros.

8. Capacitors and Reactors (columns 107-122)

Capacitors are entered as + B, and reactors are entered as G and -B in per unit at one per unit voltage. If G values are not available, then zero must be entered.

If both capacitors and reactors are present at the same bus, the B will be the net value of the combination. Switching of capacitors or reactors is not provided for in the bus data. Information in this regard should be forwarded in the letter of transmittal.

9. Bus Type (column 26)

The bus type is indicated by a one digit integer from 0 to 3 as outlined below:

Type 0 - Unregulated bus (Load Bus)
Type 1 - Hold Mvar generation within voltage limits.
Type 2 - Hold bus voltage within generator Mvar limits (Regulated Generator Bus)
Type 3 - Hold bus voltage and angle (Swing Bus)

Some load flow programs may have more bus types than indicated above. If the sender is unable or does not desire to change the bus types to conform to those above, he should describe these non-standard bus types in the letter of transmittal. Figure 4 indicates the additional data to be entered for each of these bus types using typical numerical values.

The figure illustrates that an unregulated bus with fixed Mvar generation can be represented as a Type 0 or Type 2. The first Type 2 entry (Sequence Number 3) shown indicates a bus with fixed Mvar generation of 30.0. The desired voltage should be equal to the final voltage in this case.

If a generator bus is controlling the voltage at another bus (Sequence Number 5 in figure 4, the voltage to be held at that remote bus is entered in the desired voltage field and the number of that remote bus is entered in the remote control bus number field of the generator.

A master swing bus must always be present.

Bus Data - Optional

If the following optional bus data is not provided, zeros must be entered:

1. Loss Zone (columns 21-23)

A three digit integer from 1 to 999 used in addition to the area number. Enter a zero or the appropriate zone number.

2. Base kV (columns 77-83)

Enter a zero or the appropriate kV base.

Branch Data

Branch data must be entered as outlined below and as shown in Figure 5. Examples of various ways of providing branch data are illustrated in Figure 6.

TAP BUS	Z BUS	AREA	ZONE	CIRCUIT	TYPE	IMPEDANCE R PU	IMPEDANCE X PU	CHARGING B PU	LINE MVA RATINGS 1	LINE MVA RATINGS 2	LINE MVA RATINGS 3	CONTROL BUS	SIDE
Columns 1, 2, 5	10		16	17, 18	19		30	41	50	56	62	68	73, 74, 75
BRANCH DATA FOLLOWS								NNNNN ITEMS (HEADER)					
NNNN	NNNN					± XX.XXXXXX	± XX.XXXXXX	XXX.XXXXX	NNNNN	NNNNN	NNNNN	NNNN	N
-999	(DELIMITER)												

TRANSFORMER FINAL RATIO	TRANSFORMER FINAL ANGLE	TAP OR PHASE SHIFTER RANGE MIN	TAP OR PHASE SHIFTER RANGE MAX	STEP SIZE	VOLTAGE, MVAR OR MW LIMITS MIN	VOLTAGE, MVAR OR MW LIMITS MAX	SEQ. NO.
Columns 76, 77	83	91	98	105	112	120	129, 130, 131, 132
X.XXXX	±ØØØ.ØØ	X.XXXX	X.XXXX	.XXXXX	X.XXXX	X.XXXX	NNNN
		± ØØØ.ØØ	± ØØØ.ØØ	ØØØ.ØØ	± XXXX.X	± XXXX.X	

Figure 5. Branch Data

1	2														74	75
	T B	TAP BUS	Z BUS	AREA	ZONE	CIRCUIT	TYPE	IMPEDANCE R PU	X PU	CHARGING B PU	LINE MVA RATINGS 1	2	3	CONTROL BUS	SIDE	
B	R	ANCH DATA FOLLOWS								7 ITEMS						
		31	40	2	1	1	0	0.001900	0.021301	0.36800	1200	1500	2000	0	0	
		45	912	2	1	1	1	0.000500	0.011700	0.0	0	0	0	0	0	
		94	95	2	2	1	2	0.000800	0.015500	0.0	0	0	0	94	0	
	1	70	169	3	0	1	3	0.005200	0.017400	0.0	1000	1500	2000	170	0	
	2	14	835	3	0	1	4	0.001000	0.007000	0.01300	0	0	0	214	0	
	5	82	583	8	0	1	2	0.0	0.019500	0.0	0	0	0	582	0	
	6	72	673	12	0	1	2	0.0	0.031900	0.0	0	0	0	660	1	
-	9	99														

76	77									131	132
	F R	TRANSFORMER FINAL RATIO	FINAL ANGLE	TAP OR PHASE SHIFITER RANGE MIN	MAX	STEP SIZE	VOLTAGE, MVAR OR MW LIMITS MIN	MAX	S N	E O	Q .
	0	.0	0.0	0.0	0.0	0.0	0.0	0.0			1
	1	.0250	0.00	0.0	0.0	0.0	0.0	0.0			2
	0	.9800	0.00	0.9800	0.9800	0.01000	0.5000	1.5000			3
	1	.0120	0.00	0.8324	1.1351	0.00200	-50.0	50.0			4
	1	.0000	-38.00	-40.00	0.00	2.00	175.0	225.0			5
	0	.9660	0.00	0.9090	1.1110	0.01000	0.9535	0.9925			6
	1	.0140	0.00	0.9400	1.0400	0.0	1.0140	1.0140			7

NOTES

(1) BRANCH 1 IS TRANSMISSION LINE

(2) BRANCH 2 IS A FIXED TAP TRANSFORMER

(3) BRANCH 3 IS A FIXED TAP TRANSFORMER HOWEVER IT IS ENTERED AS A VARIABLE TAP (TYPE 2) WITH MIN TAP = MAX TAP = FINAL TAP

(4) BRANCH 4 IS A VARIABLE TAP TRANSFORMER CONTROLLING THE MVAR FLOW AT BUS 170 BETWEEN -50 AND +50 MVAR

(5) BRANCH 5 IS A PHASE SHIFTER CONTROLLING THE MW FLOW AT BUS 214 BETWEEN 175 & 225 MW

(6) BRANCH 6 IS A VARIABLE TAP TRANSFORMER CONTROLLING THE VOLTAGE AT BUS 582 BETWEEN 0.9535 & 0.9925 PU

(7) BRANCH 7 IS A VARIABLE TAP TRANFORMER CONTROLLING THE VOLTAGE AT A REMOTE BUS (660) AT 1.0140 PU

Figure 6. Representation of Branch Data

Only bus numbers are provided for in the branch data because of a significant reduction in the number of cards required when that method of transfer is used. The bus name is already available in the bus data and the recipient can substitute the bus name for the bus number in his conversion program if he prefers.

Line Data - Mandatory: The following data is mandatory for transmission lines. Zeros are entered for all the transformer items in columns 69-126 on tape. If cards are being transferred, the second card (containing the transformer items) must not be included.

1. Terminal Identification (columns 1-4 and 6-9)

Two four digit integers identifying the "from" and "to" bus numbers.

2. Circuit Number (column 17)

A one digit integer from 1 to 9 used for numbering of parallel lines. If not available, the circuit number for parallel lines should be generated by the sender. A single line should have the circuit number 1.

3. Branch Impedance (columns 20-39)

Branch impedance R + jX in per-unit. A zero impedance line must not be included, unless it is a jumper line. It will be the responsibility of the recipient to check for these jumper lines.

4. Line Charging (columns 41-49)

Total line charging, +B (susceptance), in per-unit.

5. Branch Type (column 19)

A one digit branch type code from 0 to 4 is provided to indicate whether the branch is a line or transformer. Transmission lines are Type 0.

Transformers and Phase Shifter Data - Mandatory: The following data is mandatory for transformers and phase shifters. Figure 7 shows transformer and phase shifter conventions which are to be used for specifying the voltage ratio and phase angle.

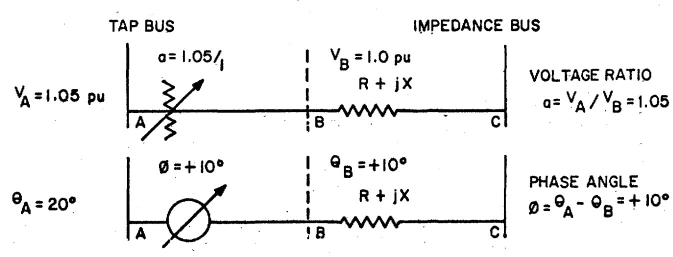

Figure 7. Transformer and Phase Shifter Conventions

For transformers, the final voltage ratio in per unit and zero phase angle is entered. For phase shifting transformers, the final phase angle in degrees and one per-unit voltage ratio is entered. For combined transformers with both phase shifting and voltage con-

Table II

Transformer and Phase Shifter Types

Branch Type	Controlled Bus No. Cols 69-72	Controlled Bus Side Col 74	Final Voltage Ratio Cols 77-82	Final Phase Angle Cols 84-90	Voltage Ratio or Phase Angle Limits Min Cols 91-97	Voltage Ratio or Phase Angle Limits Max Cols 98-104	Step Size Cols 105-111	Voltage, Mvar or Mw Limits Min Cols 113-119	Voltage, Mvar or Mw Limits Max Cols 120-126
1	0	0	1.0250	0.00	0.0	0.0	0.0	0.0	0.0
1	0	0	1.0000	20.00	0.0	0.0	0.0	0.0	0.0
1	0	0	1.0250	20.00	0.0	0.0	0.0	0.0	0.0
2	94	0	0.9800	0.00	0.9800	0.9800	0.01000	0.5000	1.5000
2	582	0	0.9660	-10.00	0.9090	1.1110	0.01000	0.9535	0.9925
2	660	1	1.0140	0.00	0.9400	1.0400	0.0	1.0140	1.0140
3	170	0	1.0120	0.00	0.8324	1.1351	0.00200	-50.0	50.0
4	214	0	1.0000	-38.00	-40.00	0.000	2.00	175.0	225.0

trol, the appropriate voltage ratio and phase angle should be provided.

1. Terminal Identification (columns 1-4 and 6-9)

   Two four digit bus numbers identifying the transformer or phase shifter terminals. The first bus number entered must be the tap side of the transformer or phase shifter.

2. Circuit Number (column 17)

   A one digit integer from 1 to 9 used for numbering parallel transformers. If not available, the circuit number for parallel transformers should be generated by the sender. A single transformer or phase shifter must have the circuit number 1.

3. Branch Impedance (columns 20-39)

   Branch impedance R + jX in per-unit. A zero impedance transformer must not be included.

4. Line Charging (columns 41-49)

   Enter a zero unless the transformer has been combined with a transmission line. In that case, enter the line charging.

5. Branch Type (column 19)

   Types of transformers or phase shifters are entered as a one digit code from 1 to 4, as follows:

   Type 1 - Fixed voltage ratio and/or fixed phase angle

   Type 2 - Fixed phase angle and variable voltage ratio with voltage control (LTC)

   Type 3 - Fixed phase angle and variable voltage ratio with Mvar control

   Type 4 - Fixed voltage ratio and variable phase angle with Mw control

   Provision is not made for a transformer with both variable tap and variable angle control. In these cases, it is suggested that the variable tap data be entered as a Type 2 or 3 and the information concerning the variable angle data be forwarded in the letter of transmittal.

6. Additional Data

   Table II illustrates the additional data required for each transformer or phase shifter type.

Table II illustrates that a fixed voltage ratio and fixed phase angle transformer (Type 1) can be represented as a Type 2 transformer (LTC) as illustrated above (first Type 2 entry). The voltage ratio limits are set equal to the final ratio and wide voltage limits are entered. The control bus must be one of the transformer terminals and the "side" code must be zero.

If the transformer is to hold a bus voltage between two voltage limits the appropriate limits are entered (second Type 2 entry in Table II). If the transformer is to hold a bus at a specific voltage, the voltage limits are set equal to that desired voltage and the actual step size or zero is entered (third Type 2 entry).

The bus number whose voltage is to be controlled by a Type 2 transformer must be entered in the control bus field whether it is one of the transformer terminals or remote from either side of the transformer.

The location of the controlled bus for a transformer is given by the following integer code in the "side" field:

0 - the controlled bus is one of the transformer terminals

1 - the remote controlled bus is near the tap side

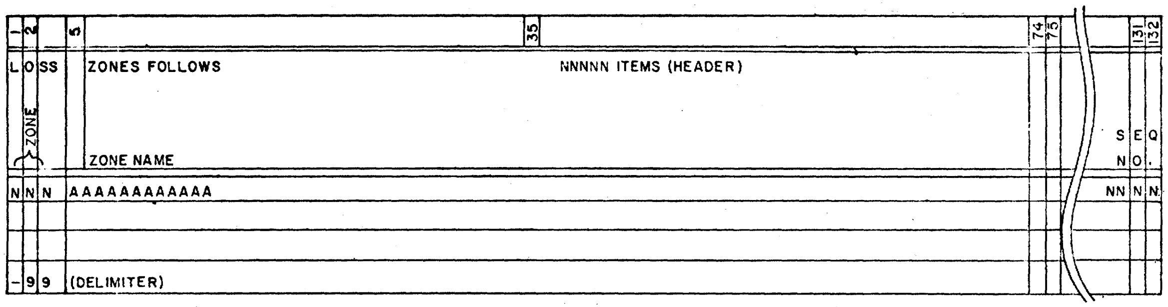

Figure 8. Loss Zone Data

2 - the remote controlled bus is near the impedance side

The controlled bus number for branch Types 3 and 4 must be one of the transformer terminals since the Mvar flow (Type 3) and the Mw flow (Type 4) must be measured at the transformer terminals. The "side" code must, therefore, be zero.

Branch Data - Optional: The following data is optional for transmission lines, transformers and phase shifters. If this optional data is not provided, zeros must be entered.

1. Line Area (columns 11-12)

   A two digit integer from 1 to 99 indicating in which company or region the branch is located. This area number should agree with one of the terminal bus areas. For tie lines, the line area indicates ownership or the area to which the losses should be assigned. This area number is not related to the meter bus location. Enter a zero or the appropriate area number.

2. Loss Zone (columns 13-15)

   A three digit integer from 1 to 999 used to define zone of loss calculation. Enter a zero or the appropriate zone number.

3. Line Ratings (columns 51-55, 57-61 and 63-67)

   Space is provided for three branch Mva ratings, with rating #1 being the lowest. The letter of transmittal should explain these ratings. Enter zeros or the appropriate values. If actual values are entered, they should be entered with the lowest non-zero value in the left-hand field.

Loss Zones

For those load flow programs which use a three digit zone number to represent sub-areas (which may overlap the bus areas), provision has been made for entering the zone number and a twelve character name for each of these loss zones. Data must be entered as shown in Figure 8. The loss zones are optional but the header and delimiter must be provided.

Interchange Data

Since many load flow programs require that interchange data be provided for all areas, whereas other programs permit areas to be uncontrolled (i. e. areas are used as loss areas not interchange areas); the sender should provide interchange data for all areas represented in the load flow. For these uncontrolled areas where interchange data is not available, the sender should enter a large tolerance (say 999. 99 Mw) and arbitrary (non zero) values for the alternate swing bus number and scheduled export.

Interchange data must be entered as outlined below and shown in Figure 9. Two examples of providing interchange data are shown in Figure 10. The first example illustrates the case where all the data is available. The second example illustrates the case where only the alternate swing bus number, export, and tolerance are known for certain areas and none of the required data is available for the remaining areas. Note that all alpha-numeric data (i. e. area code, alternate swing bus name and area name) should be left justified to avoid loss of information through truncation. The sign convention for the scheduled export is plus (+) to indicate that an area is selling power (net flow out), and minus (-) to indicate that an area is buying power (net flow in).

Interchange Data - Mandatory: The following data must be entered for all all areas:

1. Interchange Area Number (columns 1-2)
2. Alternate Swing Bus Number (columns 4-7)

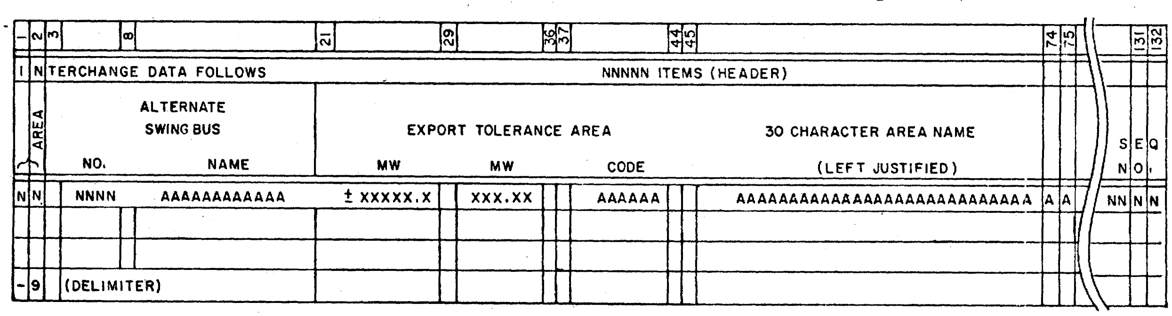

Figure 9. Interchange Data

1	2	ALTERNATE SWING BUS NO. NAME	EXPORT MW	TOLERANCE MW	AREA CODE	AREA NAME	74	75	131 SEQ. NO.	132
				EXAMPLE 1						
I	N	TERCHANGE DATA FOLLOWS		4 ITEMS						
	2	126 02 WEADK W 138	-111.0	10.00	MPP	MICHIGAN PØWER PØØL				1
	3	188 03 MANBY 230	0.0	10.00	HEPC	ØNTARIØ HYDRØ				2
	4	881 04 CRAWFRD 69	-1146.0	10.00	ILL	ILLINØIS AND WEST				3
	7	409 07 MUSK RV 345	1257.0	100.00	AEP	AMERICAN ELECTRIC POWER				4
-	9									
				EXAMPLE 2						
I	N	TERCHANGE DATA FOLLOWS		6 ITEMS						
	2	126 0	-111.0	10.00	SYS 2 0					1
	3	188 0	0.0	10.00	SYS 3 0					2
	4	881 0	-1146.0	10.00	SYS 4 0					3
	5	283 0	500.0	999.99	SYS 5 0					4
	6	302 0	-500.0	999.99	SYS 6 0					5
	7	409 0	1257.0	100.00	SYS 7 0					6
-	9									

NOTE: IN EXAMPLE 2, DUMMY VALUES WERE ENTERED FOR ALTERNATE SWING BUS NUMBERS, MW EXPORT AND MW TOLERANCE FOR AREAS 5 AND 6 AS WELL AS THE AREA CODE FOR ALL AREAS

Figure 10. Representation of Interchange Data

The alternate swing bus is a generator bus which controls area interchange.

3. Scheduled Mw Export (columns 21-28)
4. Mw Tolerance (columns 29-35)
5. Area Code (columns 38-43)

Interchange Data - Optional: The following data is optional and either the appropriate data or a zero should be entered:

1. Alternate Swing Bus Name (columns 9-20)
2. Area Name (columns 46-75)

Tie Line Data

Tie line data should be provided for all areas represented in the load flow as shown in Figure 11. The sender should endeavor to supply this information.

The following data should be provided in the tie line list. This list is a single entry list, i.e. the tie lines are entered only once.

1. Meter Bus Number (columns 1-4)
2. Meter Bus Area (columns 7-8)
3. Non-Meter Bus Number (columns 11-14)
4. Non-Meter Bus Area (columns 17-18)
5. Circuit Number (column 21)

The meter bus is the terminal at which the tie line flow is measured. If this information is not available to the sender, he can arbitrarily assume either the lower numbered bus or the bus whose area is the same as the area of the tie line.

1	2		7	11	17	21	35	74	75	131	132
T	I	E LINES FOLLOW					NNNNN ITEMS (HEADER)				
M	E	TER BUS NO. AREA		NON-METER BUS NO. AREA		CIRCUIT				SEQ NO.	
N	N	NN	NN	NNNN	NN	N				NN N	N
-	9	99 (DELIMITER)									
E	N	D OF DATA									

Figure 11. Tie Line Data

Discussion

T. M. Piascik (American Electric Power Service Corporation, New York, N.Y. 10004): Common Data Format (CDF) has been used rather extensively and successfully for exchange of solved load flow data by the Basic Data Preparation Group (BDP), which operates under the direction of MAAC, ECAR, NPCC, VACAR Joint Inter-Area Review Committees and is responsible for the development and distribution of interregional load flow cases.

As part of BDP's activities, an operating base load flow model is developed prior to the summer and winter peak load periods of each year. This base model, which contains approximately 4000 busses and 7000 lines is developed on the AEP computer facilities and includes detailed representation of the interconnected network from approximately the Mississippi River to the Atlantic Ocean. The Basic Data Preparation Group is also involved in the development of future system models and in the establishment of an extensive base case library.

Each year the BDP handles approximately twenty Common Data Format Exchanges in the development and distribution of the seasonal operating model and about ten Common Data Format Exchanges for the future system models. As applied to these activities, CDF has exhibited the speed, flexibility, and accuracy requirements necessary to reduce the overall development efforts. However, we have experienced some delays and problems in reading certain CDF tapes, caused by: (1) missing base MVA, (2) desired voltage on TCUL transformers located in the bus list rather than the branch list, (3) zero impedance lines and,(4) the sum of interchange schedules not equal to zero. For the most part, Common Data Format has been very successfully applied to these development efforts and will be continued as one of the primary tools used in the development and distribution of large interregional load flow studies.

Manuscript received February 12, 1973.

Charles W. King (University Computing Utility, Utility Consulting Services, Dallas, Tex. 75222): As a member of a service company which performs large load flow studies for many electric utility companies, we have found the Common Format for exchange of data to be extremely valuable. Since the early days of the MIIO effort, we have worked with data in this format. Our library includes a series of programs for conversion to and from our many load flow and network reduction programs.

We believe the present status of the basic format and its documentation to be excellent and cannot suggest any meaningful changes. Because we frequently become involved in the transfer of many cases, we do have some comments regarding the "mechanics of transfer".

1. The standard characteristic of "unblocked records" should be changed to a negotiable item between the two parties exchanging the tape. There are many efficiencies to be gained by blocking 5 or 10 logical records per physical record.

2. Because of the increased transmittal of data between companies and power pools, the recommended procedure of one case per tape has become an unnecessary burden. Multiple cases should be placed on the same tape separated by end-of-files.

The following comments may be of interest.

a. Deviations from the prescribed format occur most often in the case identification record (usually contains a title with no regard for format or mention of MVA base) and in the sequence numbers (usually do not start at 1 for each data group).

b. The bulky listing of the common format tape is rarely used.

c. The copy of the load flow printout with data dump is most convenient on micro-fiche.

d. The receiving company rarely uses all the data on the tape. Selected areas of the data are extracted for use; the data which is used is usually renumbered; equivalents are often made of the data as a first step.

For these reasons we immediately perform an "edit" of the data. This program prepares a report for each area which includes the number of circuits and buses, the tie-lines, the bus number ranges and the bus numbers with names.

Because these edit reports are so useful, we have contemplated sending them with each transmittal instead of the bulky listing of all data on the tape.

In summary, this effort to establish a common format for data exchange has succeeded. It is being widely used and its use will grow throughout the industry. It has facilitated the timely exchange of data. Those responsible are to be commended.

Manuscript received February 16, 1973.

W. R. Schmus (Southern California Edison Company, Rosemead, Calif. 91770): It is recognized that IEEE common format(s) were originally developed at great effort by eastern and central utilities and regional councils to facilitate the exchange of load flow data and solutions for the purpose of coordinating transmission capacity requirements and intertie loadings. It is evident that the common format became essential to these systems characterized by relatively close knit networks of lines and interconnections and has been of great value in making coordinated studies possible.

The system of the Western Systems Coordinating Council on the other hand has no strong ties to other areas and has not realized a need to exchange data outside WSCC. Thus, WSCC has not participated actively in the development of the IEEE common formats. Out of a need to exchange data among members of the council, the WSCC developed formats for input to load flow and stability programs. Because the models in the WSCC programs are more detailed than average for simulation purposes, the formats can accommodate more information than those proposed by IEEE. Our formats are therefore not compatible with the IEEE formats, and significant data reduction would be required to convert most WSCC load flow data to IEEE formats. WSCC has decided not to take any action on the IEEE common formats until there is sufficient exchange of data required with other councils to justify the preparation of suitable conversion programs.

Most of the interconnecting lines in the WSCC area are limited in transfer capability by dynamic (stability) factors rather than thermal capacity. It would seem reasonable that other regions have similar situations. Does IEEE plan to work toward the development of common stability formats?

Manuscript received February 20, 1973.

H. W. Colborn, Chairman, IEEE Working Group on a Common Format for Exchange of Solved Load Flow Data of Power System Engineering Committee: The Working Group wishes to thank the discussers for their time and effort. Mr. King and Mr. Piascik point out some deviations from the exchange format which they have experienced, and these may serve as warnings of pitfalls to be avoided. Errors such as these may be minimized by proper use of the transmittal letter and careful description of the characteristics of the data being transferred. We are pleased to note the wide acceptance of CDF in the interregional reliability council organizations. Mr. King suggests that blocking of logical records be allowed through negotiation of the two parties. This appears to be a reasonable solution to the problem faced by the Working Group in not being able to allow blocking to become an option of the sender. As well, there seems to be no reason why multiple case tapes should not be transferred, as long as it is not to be regarded as the sender's option, but is agreed upon by both sender and recipient. Mr. Schmus points out a difficulty of the CDF, particularly should solved cases be exchanged between WSCC and other councils, lies in the inability to represent more complex voltage regulation, series capacitors, "longer" transmission lines, etc. In addition, he notes that stability data transfer is of paramount importance in the west, which is beyond the present capability of CDF. Both of these points are quite valid. The Working Group's scope and assignment, which includes the responsibility of keeping abreast of changes, certainly implies the development of a format which will include transfer of data as required in the Western Systems. Additionally, the Working Group has the responsibility of producing a Common Format for transfer of stability data, as standardization of that data representation progresses in other IEEE groups. Thus, both of these points are objectives which we hope to achieve in the future. Mr. King noted that "those responsible are to be commended," and we believe that we should make special mention of the direction and coordinating efforts provided CDF in its formation by Messrs. Marriage and Rubino of Ontario Hydro.

Note should be taken of an error in Figure 3, wherein the column between bus number and bus name should be column 5 instead of column 6, and the column designated 60 should be 59. Similarly, in Figure 5, column 41 should be labeled 40.

Manuscript received April 25, 1973.