

# 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

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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.

## 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



## 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

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)

BUS NO.	BUS NAME (LEFT JUSTIFIED)	AREA	ZONE	TYPE	FINAL VOLTS PU.	FINAL ANGLE DEG.	LOAD		GENERATION	
							MW	MVAR	MW	MVAR
BUS	DATA FOLLOWS	8 ITEMS								
31	02PNTIAC345	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
89	02GARFLD 138	2	2	2	0.9841	-26.11	136.70	72.40	0.00	30.0
125	02WEADK B230	2	2	2	1.0350	-19.69	68.10	32.00	285.00	91.7
142	03PINARD 230	3	0	2	1.0400	36.89	0.0	0.0	433.00	-38.0
143	03PINARD 500	3	0	0	1.0583	34.07	0.0	0.0	0.0	0.0
239	04DRESDEN 138	4	0	1	1.0300	-30.65	85.00	0.00	200.00	76.0
370	07SPORN 138	7	0	3	1.0350	0.00	607.00	203.00	644.31	99.2
999										

BASE KV	DESIRED VOLTS PU.	MVAR OR VOLTAGE LIMITS		RESISTORS, REACTORS OR CAPACITORS		REMOTE CONTROL BUS NO.	SEQ NO.
		MAX	MIN	G PU.	B PU.		
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.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132
BRANCH DATA FOLLOWS										NNNNN ITEMS (HEADER)																																																																																																																									
TAP BUS		Z BUS		AREA		ZONE		CIRCUIT		TYPE		IMPEDANCE										CHARGING										LINE MVA RATINGS										CONTROL BUS		SIDE																																																																																							
												R PU										X PU										B PU										1										2										3																																																																					
NN NN		NNNN										± XX.XXXXXX										± XX.XXXXXX										XXX.XXXXXX										NNNNN										NNNNN										NNNNN										NNNN		N																																																									
-9 99		(DELIMITER)																																																																																																																																	

76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							

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TAP BUS	Z BUS	AREA	ZONE	CIRCUIT TYPE	IMPEDANCE		CHARGING B PU	LINE MVA RATINGS			CONTROL BUS	SIDE	
					R PU	X PU		1	2	3			
BRANCH 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
170	169	3	0	1	3	0.005200	0.017400	0.0	1000	1500	2000	170	0
214	835	3	0	1	4	0.001000	0.007000	0.01300	0	0	0	214	0
582	583	8	0	1	2	0.0	0.019500	0.0	0	0	0	582	0
672	673	12	0	1	2	0.0	0.031900	0.0	0	0	0	660	1
999													

FINAL RATIO	TRANSFORMER FINAL ANGLE	TAP OR PHASE SHIFTER RANGE		STEP SIZE	VOLTAGE, MVAR OR MW LIMITS		S E Q N O
		MIN	MAX		MIN	MAX	
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 TRANSFORMER 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.

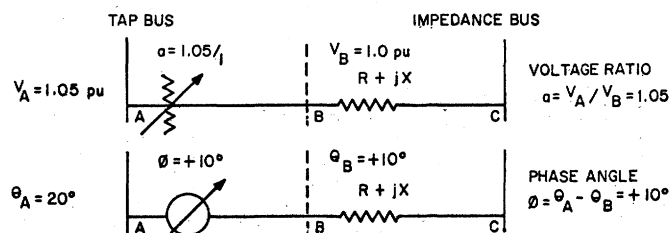


Figure 7. Transformer and Phase Shifter Conventions

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		Final Voltage Ratio Cols 77-82	Final Phase Angle Cols 84-90	Voltage Ratio or Phase Angle Limits		Step Size Cols 105-111	Voltage, Mvar or Mw Limits	
	No.	Side			Min	Max		Min	Max
	Cols 69-72	Col 74			Cols 91-97	Cols 98-104		Cols 113-119	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

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192	193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216	217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264	265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288	289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312	313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336	337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360	361	362	363	364	365	366	367	368	369	370	371	372	373	374	375	376	377	378	379	380	381	382	383	384	385	386	387	388	389	390	391	392	393	394	395	396	397	398	399	400	401	402	403	404	405	406	407	408	409	410	411	412	413	414	415	416	417	418	419	420	421	422	423	424	425	426	427	428	429	430	431	432	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447	448	449	450	451	452	453	454	455	456	457	458	459	460	461	462	463	464	465	466	467	468	469	470	471	472	473	474	475	476	477	478	479	480	481	482	483	484	485	486	487	488	489	490	491	492	493	494	495	496	497	498	499	500	501	502	503	504	505	506	507	508	509	510	511	512	513	514	515	516	517	518	519	520	521	522	523	524	525	526	527	528	529	530	531	532	533	534	535	536	537	538	539	540	541	542	543	544	545	546	547	548	549	550	551	552	553	554	555	556	557	558	559	560	561	562	563	564	565	566	567	568	569	570	571	572	573	574	575	576	577	578	579	580	581	582	583	584	585	586	587	588	589	590	591	592	593	594	595	596	597	598	599	600	601	602	603	604	605	606	607	608	609	610	611	612	613	614	615	616	617	618	619	620	621	622	623	624	625	626	627	628	629	630	631	632	633	634	635	636	637	638	639	640	641	642	643	644	645	646	647	648	649	650	651	652	653	654	655	656	657	658	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673	674	675	676	677	678	679	680	681	682	683	684	685	686	687	688	689	690	691	692	693	694	695	696	697	698	699	700	701	702	703	704	705	706	707	708	709	710	711	712	713	714	715	716	717	718	719	720	721	722	723	724	725	726	727	728	729	730	731	732	733	734	735	736	737	738	739	740	741	742	743	744	745	746	747	748	749	750	751	752	753	754	755	756	757	758	759	760	761	762	763	764	765	766	767	768	769	770	771	772	773	774	775	776	777	778	779	780	781	782	783	784	785	786	787	788	789	790	791	792	793	794	795	796	797	798	799	800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815	816	817	818	819	820	821	822	823	824	825	826	827	828	829	830	831	832	833	834	835	836	837	838	839	840	841	842	843	844	845	846	847	848	849	850	851	852	853	854	855	856	857	858	859	860	861	862	863	864	865	866	867	868	869	870	871	872	873	874	875	876	877	878	879	880	881	882	883	884	885	886	887	888	889	890	891	892	893	894	895	896	897	898	899	900	901	902	903	904	905	906	907	908	909	910	911	912	913	914	915	916	917	918	919	920	921	922	923	924	925	926	927	928	929	930	931	932	933	934	935	936	937	938	939	940	941	942	943	944	945	946	947	948	949	950	951	952	953	954	955	956	957	958	959	960	961	962	963	964	965	966	967	968	969	970	971	972	973	974	975	976	977	978	979	980	981	982	983	984	985	986	987	988	989	990	991	992	993	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217	1218	1219	1220	1221	12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74	75	76	77	78	79	80	81	82
ALTERNATE SWING BUS		EXPORT	TOLERANCE	AREA	AREA NAME			SE NO
NO.	NAME	MW	MW	CODE				
EXAMPLE 1								
1	INTERCHANGE DATA FOLLOWS			4 ITEMS				
2	126 02 WEADK W138	-111.0	10.00	MPP	MICHIGAN POWER POOL			
3	188 03 MANBY 230	0.0	10.00	HEPC	ONTARIO HYDRO			
4	681 04 CRAWFRD 69	-1146.0	10.00	ILL	ILLINOIS AND WEST			
7	409 07 MUSK RV 345	1257.0	100.00	AEP	AMERICAN ELECTRIC POWER			
-9								
EXAMPLE 2								
1	INTERCHANGE DATA FOLLOWS			6 ITEMS				
2	126 0	-111.0	10.00	SYS 2 0				
3	188 0	0.0	10.00	SYS 3 0				
4	681 0	-1146.0	10.00	SYS 4 0				
5	283 0	500.0	999.99	SYS 5 0				
6	302 0	-500.0	999.99	SYS 6 0				
7	409 0	1257.0	100.00	SYS 7 0				
-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.

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

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

- Alternate Swing Bus Name (columns 9-20)
- 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.

- Meter Bus Number (columns 1-4)
- Meter Bus Area (columns 7-8)
- Non-Meter Bus Number (columns 11-14)
- Non-Meter Bus Area (columns 17-18)
- 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.

2	7	17	21	35	74	75	131
TIE LINES FOLLOW					NNNNN ITEMS (HEADER)		
METER BUS NO. AREA		NON-METER BUS NO. AREA		CIRCUIT			SE NO.
NNNN	NN	NNNN	NN	N	NNNN		
-999 (DELIMITER)							
END 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 MIO 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 ex-

change 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.

**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 inertia 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?

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**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 discussors 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.

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