0. Introduction

LMR.5 is a hybrid format, packed binary plus characters, designed for efficient re-expression of ocean surface data from the National Climatic Data Center's TD-11 (Tape Deck-11) or other formats. Packed binary methods are employed to store information common to all of TD-11, to which a variable-length string of characters is appended to represent the remainder. This is the complete report format, containing all available fields, supplemental data from original formats (e.g., elements that underwent a questionable conversion), and erroneous characters, as well as "uncertain" duplicates. It has an attachment feature that would allow easy expansion (to add derived data) or contraction (to fix the length) of a report. Nevertheless, it averages roughly one-half the size of a less complete 148-character TD-11 representation (given 8-bit character size).

It is assumed that the reader is familiar with techniques for transferring a binary block into memory and then extracting into INTEGER variables the bit strings whose lengths are given in Tables F0-1 through F0-4. Refer to supp. H for more information. For a general discussion including the advantage in execution time and storage relative to traditional techniques see [3].

Table F0-1
Location Section

#	Field	Description	True value	Units*	Base	Coded	Bits
0	RPTIN		n/a	n/a	n/a	n/a	16
1	BOX10	10 ° box	1⩽ 648**	1***	0	same	10
2	YEAR		1800⩽ 2054	1	1799	1⩽ 255	8
3	MONTH		1⩽ 12	1	0	same	4
4	DAY		1⩽ 31	1	0	same	5
5	HOUR		0⩽ 23	1	-1	1⩽ 24	5
6	X	lon	0⩽ 359.9	0.1 ° E	-1	1⩽ 3600	12
7	Y	lat	-90.0⩽ 90.0	0.1 ° N	-901	1⩽ 1801	11
8	XYI	lat/lon indic.	0⩽ 3	1	-1	1⩽ 4	3
9	CD	card deck	0⩽ 999	1	-1	1⩽ 1000	10
10	SID	source ID	0⩽ 254	1	-1	1⩽ 255	8
11	ST	ship type	0⩽ 7	1	-1	1⩽ 8	4
12	QI	quality indic.	0⩽ 2	1	-1	1⩽ 3	2
13	DS	dup status	0⩽ 5	1	-1	1⩽ 6	3
14	DC	dup check	0⩽ 2	1	-1	1⩽ 3	2
15	TC	track check	0⩽ 1	1	-1	1⩽ 2	3
16	PB	pressure bias	0⩽ 2	1	-1	1⩽ 3	2
						section total	108

* "Units" gives the smallest increment of the data that has been encoded. Thus a change of one unit in the integer *coded* value represents a change in the *true value* of one of the units shown.
** m⩽ n denotes "from m through n inclusive."
*** Units of 1 are explained in the text describing each section.

Table F0-2
Regular Section

#	Field	Description	True value	Units	Base	Coded	Bits
17	DI	wind dir. indic.	0⩽ 5	1	-1	1⩽ 6	3
18	D	wind direction	1⩽ 362	1 °	0	same	9
19	WI	wind speed indic.	0⩽ 3	1	-1	1⩽ 4	4
20	W	wind speed	0⩽ 102.2	0.1 m s^{-1}	-1	1⩽ 1023	10
21	VI	vis. indic.	0⩽ 2	1	-1	1⩽ 3	2
22	VB	visibility	90⩽ 99	1	89	1⩽ 10	4
23	PW	present weather	0⩽ 99	1	-1	1⩽ 100	7
24	W1	past weather	0⩽ 9	1	-1	1⩽ 10	4
25	W2	2nd past weather	0⩽ 9	1	-1	1⩽ 10	4
26	P	sea level pressure	870.0⩽ 1074.6	0.1 mb	8699	1⩽ 2047	11
27	TI	temp. indic.	0⩽ 5	1	-1	1⩽ 6	4
28	A	air temp.	-99.9⩽ 99.9	0.1 ° C	-1000	1⩽ 1999	11
29	WB	wet bulb temp.	-99.9⩽ 99.9	0.1 ° C	-1000	1⩽ 1999	11
30	DPT	dew point temp.	-99.9⩽ 99.9	0.1 ° C	-1000	1⩽ 1999	11
31	S	sea surface temp.	-99.9⩽ 99.9	0.1 ° C	-1000	1⩽ 1999	11
32	BI	bucket indic.	0⩽ 2	1	-1	1⩽ 3	4
33	C	total cloud amt.	0⩽ 9	1	-1	1⩽ 10	4
34	NH	lower cloud amt.	0⩽ 9	1	-1	1⩽ 10	4
35	CL	low cloud type	0⩽ 10	1	-1	1⩽ 11	4
36	HI	cloud height indic.	0⩽ 1	1	-1	1⩽ 2	2
37	H	cloud height	0⩽ 10	1	-1	1⩽ 11	4
38	CM	middle cloud type	0⩽ 10	1	-1	1⩽ 11	4
39	CH	high cloud type	0⩽ 10	1	-1	1⩽ 11	4
40	WD	wave direction	0⩽ 38	1	-1	1⩽ 39	6
41	WP	wave period	0⩽ 30	1 s	-1	1⩽ 31	5
42	WH	wave height	0⩽ 49.5	0.5 m	-1	1⩽ 100	7
43	SD	swell direction	0⩽ 38	1	-1	1⩽ 39	6
44	SP	swell period	0⩽ 30	1 s	-1	1⩽ 31	5
45	SH	swell height	0⩽ 49.5	0.5 m	-1	1⩽ 100	7
46	A6	allowance # 6 flag	0⩽ 1	1	-1	1⩽ 2	2
						section total	174

Table F0-3
Control Section

#	Field	Description	True value	Units	Base	Coded	Bits
47	CK	checksum	n/a	n/a	n/a	n/a	14
48	AC	attachment count	1⩽ 15	1	0	same	4
						section total	18
						total	300

Table F0-4
Irregular Section

#	Field	Description	True value	Units	Base	Coded	Bits
49	AL	attachment length	1⩽ 255	1	0	same	8
50	AID	attachment ID	1⩽ 15	1	0	same	4
51	AD	attachment data	n/a	n/a	n/a	n/a	n/a

Compression was achieved by packing data represented as positive integers into fields whose lengths are specified in the *bits* column of Tables F0-1 through F0-4. To accomplish this, a field's floating point *true value* (within the range of that column) was divided by the appropriate *units* (the smallest increment of the data that has been encoded). After rounding, the *base* was subtracted to produce a *coded* positive integer (within the range of that column), which was finally right-justified with zero fill in the field's appropriate position within the report. Using the sea surface temperature (field 31) *true value* 28.6 °C as an example, (28.6/0.1) − (−1000) = 1286.

Once a given field has been extracted into a *coded* value, the *true value* can be reconstructed by reversing the process:

$$true\ value = (coded + base) * units$$

The above *true value* example is reconstructed by (1286 + (−1000) * 0.1) = 28.6 °C. **NOTE: in each coded value, zero is reserved as an indicator of missing data.** Of course, none of BOX10, YEAR, MONTH, X, or Y should ever be missing, although DAY and HOUR may be missing.

Explanations for each field in Tables F0-1 through F0-4 are given under the corresponding headings that follow, where all information refers to the *true value* (unless explicit mention is made to the contrary). This supplement is largely self-contained, although some reference is made to TD-11 documentation [5], [6], [7] for fields outside the regular section.* More information about some of the fields, particularly those not in TD-11 or related to duplication elimination, will be found in supps. I, J, or K. The various indicators show the reliability or precision of the data they refer to, and may be extant only if the data are also non-missing (possibly in the erroneous attachment). Algorithms are expressed in FORTRAN.

1. Location Section

0) RPTIN

These bits are reserved for use of the RPTIN unblocking utility, where available (e.g., NCAR). Otherwise they may be ignored.

1) BOX10 10 ° box

See supp. G for a description of the 10 ° system, and supp. H for related software.

2) YEAR

The year can range from 1800 to 2054.

3) MONTH

1=January,2=February,...,12=December.

4) DAY

Day of the month.

* Notice is hereby given that some code descriptions, such as those for present weather, are quoted or paraphrased from [5] or [12] without any further indication or credit.

5) HOUR

00 to 23 GMT.

6) X longitude

7) Y latitude

Position in tenths of a degree +N,−S,+E.

8) XYI lat/lon indicator

XYI shows the precision to which X and Y were *originally* keyed, or if they are estimates derived later by interpolation between known positions (XYI = 3 is defined but as yet unused):

0 = degrees and tenths
1 = whole degrees
2 = non-random tenths
3 = interpolated

See supp. K for details on how XYI was set. XYI = 2 (non-random tenths) indicates that the tenths positions appear to be from a deck that has a mixture of degrees and tenths (random) and whole degrees (a constant value such as 0 or 5).

9) CD card deck

Number of the source card deck the report came from, as assigned by NCDC. Each CD used is given with an approximate output period of record in Table F1-1.

Table F1-1
Card Deck Assignments (GTS*)

CD	Description	Approximate** output period
110	U.S. Navy Marine	1945-1951
116	U.S. Merchant Marine	1945-1963
117	U.S. Navy Hourlies	1952-1964
118	Japanese Ships No. 1	1930-1953
119	Japanese Ships No. 2	1934-1971
128	International Marine (U.S. recruited ships punched in-house)	1900-1978
143	PMEL (Pacific Marine Environmental Laboratory) Buoy	1975-1977
150	Pacific (U.S. Responsibility) HSST Netherlands Receipts	1939-1961
151	Pacific (U.S. Responsibility) HSST German Receipts	1862-1960
152	Pacific (U.S. Responsibility) HSST U.K. Receipts	1854-1961
155	Indian (Netherlands Responsibility) HSST	1861-1960
156	Atlantic (German Responsibility) HSST	1852-1961
184	Great Britain Marine (194 Extension)	1953-1961
185	USSR Marine IGY	1957-1958
186	USSR Ice Stations	1937-1970
187	Japanese Whaling Fleet	1946-1956
188	Norwegian Antarctic Whaling Factory Ships	1932-1939
189	Netherlands Marine	1901-1959
192	Deutsche Seewarte Marine	1855-1939
193	Netherlands Marine	1800-1938
194	Great Britain Marine	1856-1955
195	U.S. Navy Ships Logs	1941-1946
196	Deutsche Seewarte Marine (192 extension)	1949-1954
197	Danish Marine	1871-1956
281	U.S. Navy MAR (Monthly Aerological Record)	1926-1945
555*	Monterey Telecom.	1966-1973
666*	Tuna Boats	1971-1975
849*	FGGE (First GARP Global Experiment)	1978-1979
850*	German FGGE	1978-1979
876-882	NDBC (NOAA Data Buoy Center)	1972-1979
888*	GWC (U.S. Air Force Global Weather Central)	1973-1979
889*	AUTODIN (Dept. of Defense Automatic Digital Network)	1972-1979
891	NODC (National Oceanographic Data Center) Surface	1900-1977
897	*Eltanin*	1962-1963
898	Japanese	1954-1974
899	South African Whaling	1900-1955
900	Australian	1931-1979
901	FOSDIC Reconstructions (card images from 16mm film)	1868-1963
902	Great Britain Marine (184 extension)	1957-1961
926	IMMPC (International Maritime Meteorological Punch Card)	1956-1979
927	International Marine (U.S. recruited ships punched in-house)	1970-1979
928	Same as 927 including OSV (Ocean Station Vessels)	1970-1974
999*	U.S. Air Force ETAC (Environmental Technical Applications Center)	1967-1969

* GTS deck (from the Global Telecommunication System); all others are manuscript data. Decks 849-850 are considered GTS although they may have been mixed.
** Period of record is exact for CMR (supp. D), except that the starting years of decks 156 and 193 are exact for LMR (both start in 1854 in CMR).

10) SID source ID

Each SID may contain a single deck or a mixture of decks; each source ID assigned to date is listed in Table F1-2 together with the format (see supp. I) and character set it was translated from, and the output period of record. (SID 0 is unused and SID 22 was assigned but never translated.)

Table F1-2
Source ID Assignments

SID	CD	Description	Format	Char	Output period
1	mix	Atlas	TD-1100	ebcdic	1800-1969
2	150-2,192	HSST Pacific	TD-1100	ebcdic	1854-1961
3	155	HSST Indian	Exchange	ebcdic	1861-1960
4	156	HSST Atlantic	Exchange	ascii	1852-1961
5	mix	Old TDF-11 Supplement B	TD-1100	ebcdic	1854-1975
6	primarily 128	Old TDF-11 Supplement C	TD-1100	ebcdic	1855-1978
7	555	Monterey Telecom.	TD-1100	ebcdic	1966-1969
8	mix	OSV (Ocean Station Vessels)	TD-1100	ebcdic	1945-1973
9	mix	OSV Supplement	TD-1100	ebcdic	1947-1973
10	mix	MSQ 486 and 105 Omissions	TD-1100	ebcdic	1854-1939
11	891	NODC Surface	TD-1100	ebcdic	1900-1975
12	891	NODC Surface Supplement	TD-1100	ebcdic	1902-1977
13	897	*Eltanin*	TD-1129M	ebcdic	1962-1963
14	898	Japanese	TD-1129	ebcdic	1954-1974
15	899	South African Whaling	TD-1129M	ebcdic	1900-1955
16	900	Australian	TD-1129	ebcdic	1931-1970
17	926	IMMPC	TD-1129	ebcdic	1956-1963
18	mix	'70s Decade	TD-1129	ascii	1970-1979
19	926	IMMPC ('70s)	TD-1129	ebcdic	1970-1979
20	mix	OSV Z ('70s)	TD-1100	ebcdic	1971-1974
21	900	Australian ('70s)	TD-1129	ebcdic	1971-1979
22	?	*Islas Orcadas* ('70s)	n/a	n/a	n/a
23	mix	'70s Mislocated Data	TD-1127	ebcdic	1970-1979
24	143,876-82	Buoy Data	TD-1129	ebcdic	1972-1979

11) ST ship type

The type of observing vessel was obtained according to supp. I, and the unreliability of this field is discussed in *COADS Release 1.*

0 = U.S. Navy or "deck" log, or unknown
1 = merchant ship or foreign military
2 = ocean station vessel -- off station or station proximity unknown
3 = ocean station vessel -- on station
4 = lightship
5 = buoy
6 = research ship
7 = expendable or mechanical bathythermograph (XBT or MBT)

12) QI quality indicator

An overall quality measure as yet undefined and maybe reserved for subsequent analysis.

13) DS dup status

Indicates duplicate status to allow for retention of unclear duplicates (see supp. K).

0 = unique
1 = best duplicate
2 = best duplicate with substitution
3 = worse duplicate, uncertain with hour cross
4 = worse duplicate, uncertain with no cross
5 = worse duplicate, uncertain with day cross

14) DC dup check

The presence of a GTS (Global Telecommunication System) and logbook duplicate provides some location verification, with greater credibility if sea level pressure P and sea surface temperature S match under allowances (see supp. K).

0 = GTS and logbook match with P and S match
1 = GTS and logbook match without P and S match
2 = not GTS and logbook match

15) TC track check

TC is currently unused, but reserved to indicate if a report was:

0 = not track checked
1 = track checked

16) PB pressure bias

PB is currently unused, but reserved to indicate the need for an adjustment because of pressure bias on a specific vessel:

0 = pressure bias adjustment unneeded
1 = pressure bias adjustment has been made
2 = pressure bias adjustment needed

2. Regular Section

17) DI wind direction indicator

DI shows the compass (and approximate precision) used for reporting the wind direction:

0 = 36-point compass
1 = 32-point compass
2 = 16 of 36-point compass
3 = 16 of 32-point compass
4 = 8-point compass
5 = 360-point compass

18) D wind direction

The wind direction is stored in whole degrees (i.e., 360 point compass), or with special codes:

361 = calm
362 = variable

For data converted from TD-11, a translation from the code value to D in whole degrees was made according to Table F2-1 (blank indicated an undefined conversion). All other data (Exchange format) were already recorded in whole degrees, so no translation was made. Consequently, for a given compass, only decks 155 and 156 (or source IDs 3 and 4) may have wind directions different than those shown in Table F2-1, since no checks for conformity were made.

Table F2-1
Translation of Wind Direction Code into Degrees

	DI				
Code	0	1	2	3	4
01	10	11			?
02	20	23	25	23	?
03	30	34			?
04	40	45		45	?
05	50	56	45		?
06	60	68		68	?
07	70	79	65		?
08	80	90		90	?
09	90	101	90		
10	100	113		113	
11	110	124	115		
12	120	135		135	
13	130	146			
14	140	158	135	158	
15	150	169			
16	160	180	155	180	
17	170	191			
18	180	203	180	203	
19	190	214			
20	200	225	205	225	
21	210	236			
22	220	248		248	
23	230	259	225		
24	240	270		270	
25	250	281	245		
26	260	293		293	
27	270	304	270		
28	280	315		315	
29	290	326	295		
30	300	338		338	
31	310	349			
32	320	360	315	360	
33	330				
34	340		335		
35	350				
36	360		360		
00(calm)	361	361	361	361	
99(var)	362	362	362	362	

The rationale for the degree values shown in Table F2-1 is as follows. DI=2 winds were translated to degrees based on the way the original 36-point values were translated to 16-point when the data were punched at NCDC. This translation was necessary since the punching equipment was designed specifically for entering 16-point winds. The 36 points were punched as the nearest point on the 16-point compass. Averaging the points included in each 16-point group results in direction values as shown. For example, 20 and 30 degrees were included as the first point (code 02) so 25 degrees is used as the best estimate of the direction in degrees. Seventy, 90, and 100 were punched as the fourth point (code 09) and 90 is used. DI = 3 winds were translated as a simple 16 point compass, since it is not clear how the 32 point winds were translated to 16 point. DI = 4 winds were indicated only in the Exchange format and had already been translated into unknown degrees, hence the question marks.

19) WI wind speed indicator

20) W wind speed

Wind speed is stored in tenths of a meter per second. WI shows the units from which W was converted and the method by which it was originally recorded:

0 = meter per second, estimated (or unknown)
1 = meter per second, measured
2 = knot, estimated (or unknown)
3 = knot, measured

NOTE: no indication is given as to the precision from which W was converted, e.g., whole knots.

21) VI visibility indicator

22) VB visibility

VI shows whether VB was:

0 = estimated (or unknown method of observation)
1 = measured
2 = fog present (rarely-used code that is now obsolete, with special meaning in conjunction with VB = 93)

Codes 90 to 99 for VB correspond to horizontal visibility at the surface in kilometers:

90 = < 0.05 kilometers
91 = 0.05
92 = 0.2
93 = 0.5
94 = 1
95 = 2
96 = 4
97 = 10
98 = 20
99 = 50 or more

NOTE: when VI = 2, and VB = 93, it means that fog was present and visibility was not reported.

23) PW present weather

Codes 00 to 99 (leading zeros are strictly notational, e.g., for use in comparison with past weather). Codes 00 to 49 indicate no precipitation at the station (e.g., ship) at time of observation.

00 = cloud development not observed.

01 = clouds generally dissolving or becoming less developed.

02 = state of the sky unchanged.

03 = clouds generally forming or developing.

04 = visibility reduced by smoke.

05 = haze.

06 = widespread dust in suspension in the air, not raised by wind at or near the station at time of observation.

07 = dust or sand raised by wind at or near the station at time of observation, but no well-developed dust whirls or sand whirls and no dust storm or sandstorm seen.

08 = well developed dust whirls or sand whirls seen at or near the station during the preceding hour or at time of observation, but no dust storm or sandstorm.

09 = dust storm or sandstorm within sight at time of observation, or at the station during the preceding hour.

10 = light fog (visibility 1,100 yards or more); synonymous with European term "mist."

11 = patches of shallow fog or ice fog at the station, not deeper than about 10 meters.

12 = more or less continuous shallow fog or ice fog at the station, not deeper than about 10 meters.

13 = lightning visible, no thunder heard.

14 = precipitation within sight, not reaching the surface of the sea.

15 = precipitation within sight, reaching the surface of the sea, but more than 5 kilometers from the station.

16 = precipitation within sight, reaching the surface of the sea, near to, but not at the station.

17 = thunderstorm, but no precipitation at time of observation.

18 = squalls at or within sight of the station during the preceding hour or at time of observation.

19 = funnel cloud or waterspout at or within sight of the station during the preceding hour or at time of observation.

Codes 20 to 29 refer to phenomena that occurred at the station during the preceding hour but not at time of observation.

20 = drizzle (not freezing) or snow grains.

21 = rain (not freezing).

22 = snow.

23 = rain and snow or ice pellets, type (a).

24 = freezing drizzle or freezing rain.

25 = shower of rain.

26 = shower of snow, or of rain and snow.

27 = shower of hail (ice pellets, type (b), snow pellets), or of rain and hail.

28 = fog or ice fog.

29 = thunderstorm (with or without precipitation).

Codes 30 to 99 refer to phenomena occurring at the ship at time of observation.

30 = slight or moderate dust storm or sandstorm has decreased during the preceding hour.

31 = slight or moderate dust storm or sandstorm with no appreciable change during the preceding hour.

32 = slight or moderate dust storm or sandstorm has begun or has increased during the preceding hour.

33 = severe dust storm or sandstorm has decreased during the preceding hour.

34 = severe dust storm or sandstorm with no appreciable change during the preceding hour.

35 = severe dust storm or sandstorm has begun or has increased during the preceding hour.

36 = slight or moderate drifting snow generally low (below eye level, less than 6 feet).

37 = heavy drifting snow generally low (below eye level, less than 6 feet).

38 = slight or moderate blowing snow generally high (above eye level, 6 feet or more).

39 = heavy blowing snow generally high (above eye level, 6 feet or more).

40 = fog or ice fog at a distance at time of observation, but not at the station during the preceding hour, the fog or ice fog extending to a level above that of the observer.

41 = fog or ice fog in patches.

42 = fog or ice fog (sky visible) has become thinner during the preceding hour.

43 = fog or ice fog (sky invisible) has become thinner during the preceding hour.

44 = fog or ice fog (sky visible) with no appreciable change during the preceding hour.

45 = fog or ice fog (sky invisible) with no appreciable change during the preceding hour.

46 = fog or ice fog (sky visible) has begun or has become thicker during the preceding hour.

47 = fog or ice fog (sky invisible) has begun or has become thicker during the preceding hour.

48 = fog, depositing rime, sky visible.

49 = fog, depositing rime, sky invisible.

Codes 50 to 99 indicate precipitation at the station at time of observation.

50 = drizzle, not freezing, intermittent, slight at time of observation.

51 = drizzle, not freezing, continuous, slight at time of observation.

52 = drizzle, not freezing, intermittent, moderate at time of observation.

53 = drizzle, not freezing, continuous, moderate at time of observation.
54 = drizzle, not freezing, intermittent, heavy (dense) at time of observation.
55 = drizzle, not freezing, continuous, heavy (dense) at time of observation.
56 = drizzle, freezing, slight.
57 = drizzle, freezing, moderate or heavy (dense).
58 = drizzle and rain, slight.
59 = drizzle and rain, moderate or heavy.

60 = rain, not freezing, intermittent, slight at time of observation.
61 = rain, not freezing, continuous, slight at time of observation.
62 = rain, not freezing, intermittent, moderate at time of observation.
63 = rain, not freezing, continuous, moderate at time of observation.
64 = rain, not freezing, intermittent, heavy at time of observation.
65 = rain, not freezing, continuous, heavy at time of observation.
66 = rain, freezing, slight.
67 = rain, freezing, moderate or heavy.
68 = rain or drizzle and snow, slight.
69 = rain or drizzle and snow, moderate or heavy.

70 = intermittent fall of snowflakes, slight at time of observation.
71 = continuous fall of snowflakes, slight at time of observation.
72 = intermittent fall of snowflakes, moderate at time of observation.
73 = continuous fall of snowflakes, moderate at time of observation.
74 = intermittent fall of snowflakes, heavy at time of observation.
75 = continuous fall of snowflakes, heavy at time of observation.
76 = ice prisms (with or without fog).
77 = snow grains (with or without fog).
78 = isolated star-like snow crystals (with or without fog).
79 = ice pellets, type (a) (sleet, U.S. definition).

80 = rain shower, slight.
81 = rain shower, moderate or heavy.
82 = rain shower, violent.
83 = shower of rain and snow mixed, slight.
84 = shower of rain and snow mixed, moderate or heavy.
85 = snow shower, slight.
86 = snow shower, moderate or heavy.
87 = slight showers of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed.
88 = moderate or heavy showers of snow pellets or ice pellets, type (b), with or without rain or rain and snow mixed.

89 = slight showers of hail, with or without rain or rain and snow mixed, not associated with thunder.

90 = moderate or heavy showers of hail, with or without rain or rain and snow, mixed, not associated with thunder.

91 = slight rain at time of observation, thunderstorm during preceding hour but not at time of observation.

92 = moderate or heavy rain at time of observation, thunderstorm during preceding hour but not at time of observation.

93 = slight snow, or rain and snow mixed, or hail, at time of observation with thunderstorm during the preceding hour but not at time of observation.

94 = moderate or heavy snow, or rain and snow mixed, or hail, at time of observation with thunderstorm during the preceding hour but not at time of observation.

95 = thunderstorm, slight or moderate, without hail, but with rain and/or snow at time of observation.

96 = thunderstorm, slight or moderate, with hail at time of observation.

97 = thunderstorm, heavy, without hail but with rain and/or snow at time of observation.

98 = thunderstorm combined with dust storm or sandstorm at time of observation.

99 = thunderstorm, heavy, with hail at time of observation.

24) W1 past weather

25) W2 second past weather

Codes 0 to 9 have the same meaning for W1 and W2, which more or less corresponds to that implied by the leading (tens) digit of present weather. The period covered by W1 and W2 is 6 hours for observations at 0000, 0600, 1200, and 1800 GMT, and 3 hours for observations at 0300, 0900, 1500, and 2100 GMT. W1 and W2 are intended to contain the higher and lower, respectively, of two codes that describe as fully as possible the weather during the appropriate period, or both W1 and W2 may contain the same code. W2 became effective only starting on 1 January 1982, so it should always be missing before that date.

0 = cloud covering one-half or less of the sky throughout the appropriate period.

1 = cloud covering more than one-half of the sky during part of the appropriate period and covering one-half or less during part of the period.

2 = cloud covering more than one-half of the sky throughout the appropriate period.

3 = sandstorm, dust storm, or blowing snow.

4 = fog, ice fog, or thick haze (U.S. includes thick smoke).

5 = drizzle.

6 = rain.

7 = snow, or rain and snow mixed.

8 = shower.

9 = thunderstorm with or without precipitation.

26) P sea level pressure

In tenths of a millibar.

27) TI temperature indicator

28) A air temperature

29) WB wet bulb temperature

30) DPT dew point temperature

31) S sea surface temperature

Temperatures are stored in tenths of a degree Celsius. TI shows the precision and units that A, WB, DPT, and S were recorded in or translated to (see supp. I):

0 = degrees Celsius and tenths
1 = whole degrees Celsius
2 = half degrees Celsius
3 = degrees Fahrenheit and tenths
4 = whole degrees Fahrenheit
5 = half degrees Fahrenheit

32) BI bucket indicator

Shows the method by which S was taken:

0 = unknown
1 = bucket
2 = implied bucket (an HSST SID or any match thereof)

NOTE: BI values 0 and 1 are unreliable at least for U.S. recruited ships (i.e., country code 0K or 02) until starting on 1 May 1973, or perhaps earlier (see *COADS Release 1*, and for country codes see [6]).

33) C total cloud amount

34) NH lower cloud amount

For C, codes 0 to 9 show the fraction of the celestial dome covered by all clouds. For NH they show the fraction of the celestial dome covered by all the low (CL) clouds and, if no CL cloud is present, the fraction covered by all the middle (CM) clouds present:

0 = clear.

1 = 1 okta or less, but not zero.

2-6 = 2-6 oktas.

7 = 7 oktas or more, but not 8 oktas.

8 = 8 oktas.

9 = sky obscured or cloud amount cannot be estimated.

35) CL low cloud type

Codes 0 to 10 show characteristics observed of clouds of the types stratocumulus, stratus, cumulus, cumulonimbus, and their variations:

0 = no stratocumulus, stratus, cumulus, or cumulonimbus.

1 = cumulus with little vertical extent and seemingly flattened, or ragged cumulus other than of bad weather, or both.

2 = cumulus of moderate or strong vertical extent, generally with protuberances in the form of domes or towers, either accompanied or not by other cumulus or by stratocumulus, all having their base at the same level.

3 = cumulonimbus the summits of which, at least partially, lack sharp outlines but are neither clearly fibrous (cirriform) nor in the form of an anvil; cumulus, stratocumulus, or stratus may also be present.

4 = stratocumulus formed by the spreading out of cumulus; cumulus may also be present.

5 = stratocumulus not resulting from the spreading out of cumulus.

6 = stratus in a more or less continuous sheet or layer, or in ragged shreads, or both, but no stratus fractus of bad weather.

7 = stratus fractus of bad weather (generally existing during precipitation and a short time before and after) or cumulus fractus of bad weather, or both (pannus), usually below altostratus or nimbostratus.

8 = cumulus and stratocumulus other than that formed from the spreading out of cumulus; the base of the cumulus is at a different level from that of the stratocumulus.

9 = cumulonimbus, the upper part of which is clearly fibrous (cirriform), often in the form of an anvil; either accompanied or not by cumulonimbus without anvil or fibrous upper part, by cumulus, stratocumulus, stratus, or pannus.

10 = low clouds not visible, owing to darkness, fog, blowing dust or sand, or other similar phenomena.

36) HI cloud height indicator

Shows if the cloud height H was:

0 = estimated
1 = measured

37) H cloud height

Codes 0 to 10. Codes 0 to 9 show the height above sea surface of the base of the lowest cloud or fragment thereof as given by Table F2-2.

Table F2-2
Cloud Height Codes

Code	Approximate height	
	Feet	Meters
0	0-149	0-49
1	150-299	50-99
2	300-599	100-199
3	600-999	200-299
4	1000-1999	300-599
5	2000-3499	600-999
6	3500-4999	1000-1499
7	5000-6499	1500-1999
8	6500-7999	2000-2499
9	$\geqslant$ 8000 or no clouds	$\geqslant$ 2500 or no clouds

Code 10 indicates H cannot be estimated because of darkness or for other reasons.

38) CM middle cloud type

Codes 0 to 10 show characteristics observed of clouds of the types altocumulus, altostratus, and nimbostratus:

0 = no altocumulus, altostratus, or nimbostratus.

1 = altostratus, the greater part of which is semi-transparent; through this part the sun or moon may be weakly visible, as through ground glass.

2 = altostratus, the greater part of which is sufficiently dense to hide the sun or moon, or nimbostratus.

3 = altocumulus, the greater part of which is semi-transparent; the various elements of the cloud change only slowly and are all at a single level.

4 = patches (often in the form of almonds or fishes) of altocumulus, the greater part of which is semi-transparent; the clouds occur at one or more levels and the elements are continually changing in appearance.

5 = semi-transparent altocumulus in bands, or altocumulus in one or more fairly continuous layers (semi-transparent or opaque), progressively invading the sky; these altocumulus clouds generally thicken as a whole.

6 = altocumulus resulting from the spreading out of cumulus (or cumulonimbus).

7 = altocumulus in two or more layers, usually opaque in places, and not progressively invading the sky; or opaque layer of altocumulus, not progressively invading the sky; or altocumulus together with altostratus or nimbostratus.

8 = altocumulus with sproutings in the form of small towers or battlements; or altocumulus having the appearance of cumuliform tufts.

9 = altocumulus of a chaotic sky, generally at several levels.

10 = middle clouds not visible, owing to darkness, fog, blowing dust or sand, or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

39) CH high cloud type

Codes 0 to 10 show characteristics observed of clouds of the types cirrus, cirrocumulus and cirrostratus:

0 = no cirrus, cirrocumulus or cirrostratus.

1 = cirrus in the form of filaments, strands, or hooks, not progressively invading the sky

2 = dense cirrus, in patches or entangled sheaves, which usually do not increase and sometimes seem to be the remains of the upper part of a cumulonimbus, or cirrus with sproutings in the form of small turrets or battlements, or cirrus having the appearance of cumuliform tufts.

3 = dense cirrus, often in the form of an anvil, being the remains of the upper parts of cumulonimbus.

4 = cirrus in the form of hooks or of filaments, or both, progressively invading the sky; they generally become denser as a whole.

5 = cirrus (often in bands converging towards one point or two opposite points of the horizon) and cirrostratus, or cirrostratus alone; in either case, they are progressively invading the sky, and generally growing denser as a whole, but the continuous veil does not reach 45 degrees above the horizon.

6 = cirrus (often in bands converging towards one point or two opposite points of the horizon) and cirrostratus, or cirrostratus alone; in either case, they are progressively invading the sky, and generally growing denser as a whole; the continuous veil extends more than 45 degrees above the horizon, without the sky being totally covered.

7 = veil of cirrostratus covering the celestial dome.

8 = cirrostratus not progressively invading the sky and not completely covering the celestial dome.

9 = cirrocumulus alone, or cirrocumulus accompanied by cirrus or cirrostratus, or both, but cirrocumulus is predominant.

10 = high clouds not visible, owing to darkness, fog, blowing dust or sand, or other similar phenomena, or more often because of the presence of a continuous layer of lower clouds.

40) WD wave direction

Codes 0 to 38. Codes 0 to 36 show the direction from which (wind) waves come, in tens of degrees:

0 = calm
1 = 005-014°
2 = 015-024°
3 = 025-034°
4 = 035-044°
5 = 045-054°
6 = 055-064°
7 = 065-074°
8 = 075-084°
9 = 085-094°
10 = 095-104°
11 = 105-114°
12 = 115-124°
13 = 125-134°
14 = 135-144°
15 = 145-154°
16 = 155-164°
17 = 165-174°
18 = 175-184°
19 = 185-194°
20 = 195-204°
21 = 205-214°
22 = 215-224°
23 = 225-234°
24 = 235-244°
25 = 245-254°
26 = 255-264°
27 = 265-274°
28 = 275-284°
29 = 285-294°
30 = 295-304°
31 = 305-314°
32 = 315-324°
33 = 325-334°
34 = 335-344°
35 = 345-354°
36 = 355-004°

Codes 37 and 38 show:

37 = waves confused, direction indeterminate (wave height $\leqslant$ 4.75 meters).

38 = waves confused, direction indeterminate (wave height $>$ 4.75 meters).

NOTE: In their conversion of data into TD-11, NCDC usually substituted wind direction into missing WD since 1 January 1968, when WD was no longer ordinarily reported. Instead of continuing this practice, modifications were made to properly QC the wave fields without actually substituting wind direction (see supp. J), thereby preserving any remaining information regarding whether WD was separately reported.

41) WP wave period

The old codes for periods WP and SP (swell period) have been converted to whole seconds as given by Tables F2-3 or F2-4, choosing the higher of 2-second class intervals where applicable. (Periods in whole seconds were taken in preference to the old codes if both were available, e.g., from TD-1127 or TD-1129.)

Table F2-3
Conversion for WP Always, and for SP Prior to 1968

Seconds	Code	Interval
5	2	5 seconds or less
7	3	6-7 seconds
9	4	8-9 seconds
11	5	10-11 seconds
13	6	12-13 seconds
15	7	14-15 seconds
17	8	16-17 seconds
19	9	18-19 seconds
21	0	20-21 seconds
22	1	over 21 seconds
0	-	calm or period not determined

Table F2-4
Conversion for SP Beginning 1 January 1968

Seconds	Code	Interval
10	0	10 seconds
11	1	11 seconds
12	2	12 seconds
13	3	13 seconds
14	4	14 seconds or more
5	5	5 seconds or less
6	6	6 seconds
7	7	7 seconds
8	8	8 seconds
9	9	9 seconds
0	-	calm or period not determined

42) WH wave height

Codes 0 to 99 show the height in 0.5 meter increments:

0 = less than 0.25 meters

1 to 99 = 0.5 to 49.5 meters

43) SD swell direction

44) SP swell period

45) SH swell height

As given by the corresponding wave fields WD, WP, and WH.

46) A6 allowance # 6 flag

Both reports matched under dupelim allowance # 6 (see supp. K) were assigned a value showing the number of hours by which the HSST Indian report lagged the deck 193 report, after which either or both reports may have been output:

0 = six hours, or
1 = seven hours

3. Control Section

47) CK checksum

A checksum was computed and stored with each report as a measure of reliability during storage and transmission. The checksum is computed by

1) Summing *coded* values of all other fields in the report besides RPTIN and the checksum.

2) Obtaining the modulo $(2^8 - 1)$ of the sum.

Repeating this calculation for every unpacked report, and then verifying that the checksum so obtained agrees with the *coded* checksum stored in the report, is strongly encouraged. For example, supposing that the *coded* values of the preceding fields 1 through 46 (excluding RPTIN) are available in an array FIELD, the checksum CK is computed and verified against the stored checksum CKS in FORTRAN as follows:

```
      INTEGER CK,J,FIELD(46),CKS
      CK = 0
      DO 500 J = 1,46
  500 CK = CK + FIELD(J)
      CK = MOD(CK,255)
      IF(CK .NE. CKS) THEN
        PRINT *,'ERROR. CK = ',CK,' .NE. CKS = ',CKS
        STOP
      ENDIF
```

Note that using modulus 2^8-1 takes into account every bit of CK, versus chopping at the eighth bit using modulus 2^8. In addition the top 6 bits are unused.

48) AC attachment count

Shows that AC attachments, as described in sec. 4, follow.

4. Irregular Section

The combined length of the preceding three sections is 300 bits, which is equivalent in length to 75 4-bit characters. Appended after bit 300 are AC attachments (unless AC is zero) whose purpose is to contain information that does not conveniently fit into the binary section of the format. Currently implemented are attachments 1, 4, and 5:

Attachment 1 = quality control flags generated in the quality control program.

Attachment 4 = supplemental data from the original input format.

Attachment 5 = fields that contain invalid characters or out of range values in the original input format.

Each attachment contains three fields:

49) AL attachment length

AL is the length of the attachment data following AID in 4-bit bytes.

50) AID attachment ID

Numeric identifier of this attachment.

1 = quality control flags
4 = supplemental data
5 = error fields

51) AD attachment data

Attachment data are defined in the following.

Attachment 1. Quality Control Flags

Flag values generated by the NCDC defined QC procedure (see supp. J) were stored in TD-11 as alphabetic characters given in Table F4-1, together with their *coded* (or *true value*) equivalents as stored in LMR.

Table F4-1
QC Flag Meaning

Char	Coded	Weight	Meaning	Reason
R	1	0	correct	--
A	2	1	correctable	legality
B	3	1	correctable	internal consistency
J	4	2	suspect	internal consistency
K	5	2	suspect	time
L	6	2	suspect	extreme (mean $\pm$ 4.8 σ)
M	7	3	erroneous	legality
N	8	3	erroneous	internal consistency
Q	9	3	erroneous	extreme (mean $\pm$ 5.8 σ)
S	10	3	missing	--

One of the possible flag values was assigned to each of the flags given in Table F4-2.

Table F4-2
QC Flag Order and Possible Values

#	Flag	Coded	Bits	Possible flag values (X)									
				R	A	B	J	K	L	M	N	Q	S
1	ship position	1$\leqslant$10	4	X						X			
2	wind	1$\leqslant$10	4	X	X		X			X		X	X
3	visibility	1$\leqslant$10	4	X						X			X
4	present weather	1$\leqslant$10	4	X		X	X		X	X			X
5	past weather	1$\leqslant$10	4	X			X			X			X
6	pressure	1$\leqslant$10	4	X					X	X		X	X
7	air temp.	1$\leqslant$10	4	X			X		X	X	X	X	X
8	wet bulb temp.	1$\leqslant$10	4	X		X			X	X	X	X	X
9	dew point temp.	1$\leqslant$10	4	X		X			X	X	X	X	X
10	sea surface temp.	1$\leqslant$10	4	X					X	X		X	X
11	cloud	1$\leqslant$10	4	X		X	X				X		X
12	wave	1$\leqslant$10	4	X	X	X	X			X	X	X	X
13	swell	1$\leqslant$10	4	X		X	X			X	X	X	X
14	pressure tendency	1$\leqslant$10	4	X				X		X			X
15	quality code	1$\leqslant$43	8										
	total		64										

The quality code is the sum of the weight of flags 1-14. **NOTE: in each coded value, zero is reserved as an indicator of a missing flag.** Thus the quality code *true value* is actually:

quality code *true value* = *coded* − 1

For the flags, the *coded* and *true values* are the same.

Attachment 2.

Not currently implemented.

Attachment 3.

Not currently implemented.

Attachment 4. Supplemental Data

All fields not converted to binary and other designated fields are packed into a character string. For TD-1100, TD-1127, and TD-1129 formats this consists of all characters beginning in position 78, 78, and 79, respectively. For the Exchange format this consists of characters from positions 33-35 and 42-46. Refer to supp. I for more details on these formats.

Since the vast bulk of the data is numeric, or numeric overpunch, a 4/8/12-bit "ship" character set was used that maximizes compression but has close ties to ebcdic. These rules were followed in translation to the ship character set:

a) All numeric characters are translated into values 0-9 (equivalent to the low order 4 bits of ebcdic).

b) Spaces translate to the value 10.

c) A subset of other characters is stored as 8-bit where the first 4 bits contain 12, 13, or 14. (See Table F4-3.)

d) Characters not appearing in Table F4-3 are represented by a 4-bit flag of 15, followed by the original 8-bit character.

e) More than 2 consecutive spaces are represented by a 4-bit flag of 11, followed by a 4-bit count of the (number minus three) of consecutive spaces that these 8 bits replaced. Thus a count of 0=3 spaces, 1=4 spaces,..., 15=18 spaces. Trailing spaces are simply omitted.

Table F4-3
4/8/12-bit Ship Character Table*

		High-order 4-bit byte				
		Empty	11	12	13	14
	0	0	3 sp	(12-0)	(11-0)	
	1	1	4 sp	A	J	/
	2	2	5 sp	B	K	S
	3	3	6 sp	C	L	T
	4	4	7 sp	D	M	U
	5	5	8 sp	E	N	V
	6	6	9 sp	F	O	W
low-order	7	7	10 sp	G	P	X
4-bit byte	8	8	11 sp	H	Q	Y
	9	9	12 sp	I	R	Z
	10	1 sp	13 sp	&	–	*
	11	8-bit	14 sp	+		
	12	8-bit	15 sp			
	13	8-bit	16 sp			
	14	8-bit	17 sp			
	15	12-bit	18 sp			

* Read the value of the first 4-bit byte as low-order. If "8-bit" is shown, this byte is read instead as high-order and the next 4-bit byte as low-order. If "12-bit" is shown, the next 8-bit byte is the original input character. A run of *n* spaces is denoted by *n* sp. Blank positions in the table will be defined as needed.