3 - LOGICAL RECORD SYNTAX

3.1 Record Format Categories

From a syntactical point of view, we can speak of two different DLIS Logical Record structures for storing information -- namely:

- an *Explicitly Formatted Logical Record*
- an *Indirectly Formatted Logical Record*

3.2 Explicitly Formatted Logical Record (EFLR)

An EFLR has a variable-length Logical Record Body (LRB). The format of the LRB is derived from an analysis of the record itself. An EFLR is defined in such a general way that it can be used to contain a wide variety of information related to logging data.

The syntax of an EFLR permits the system or the application program that is reading DLIS to interpret unambiguously the information that is contained in the EFLR. The Logical Record Type in the Logical Record Segment Header permits quick scanning of Logical Records to locate certain key types of information. The structures within the EFLR can then be interpreted hierarchically to get detailed attributes of the information.

3.2.1 EFLR: General Layout

Each EFLR encapsulates a table of information. The rows of the table represent *Objects*, and the columns of the table represent *Attributes* of the Objects. At the beginning of the table there is a *Template* that defines the columns. The table can be viewed in another way as a *Set* of Objects, all of the same *Type*, defined by the Template of the Set. Figure 3-1 illustrates a typical EFLR.

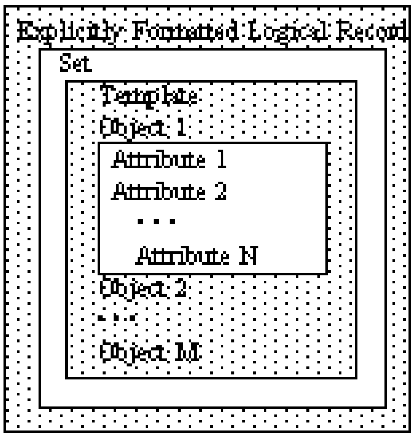


Figure 3-1. Illustration of EFLR Structure

Each EFLR contains one and only one Set. A Set is interposed between the EFLR and the Objects in the Set to provide a structure that can be named, that represents a specific collection of Objects of a given subtype of the EFLR's Type, and that can be accessed with the same syntactical machinery that is used to access Objects. Although an EFLR may contain only one Set, that Set may be one of several different types implied by the Logical Record Type of the EFLR.

Formally, a Set consists of one or more Objects of the same type, preceded by a Template. Each Object has one or more Attributes. Sets, Objects and Attributes have certain *Characteristics* which serve to distinguish one from another. Templates do not have intrinsic Characteristics. Rather, Templates are used to specify the presence, order, and default Characteristics of the Attributes of the Objects in the Set. This permits the number of explicitly present Characteristics of Attributes in the Object rows to be reduced -- to zero in some cases.

3.2.2 EFLR: Component Structure

The basic syntactic unit of an EFLR is the *Component*. Components are used for structural purposes and to carry information describing the entities, i.e., Set, Objects, and Attributes, that make up an EFLR.

The following notational conventions are used in describing Components:

- 1. The notation n‘a..x denotes a value represented in IDENT or ASCII form (see Appendix B) and consisting of the n characters a..x preceded by the length n. Examples are

  5‘Hello
  6‘Origin
  24‘This is a string of text

- 2. The notation k&j&n‘a..x denotes a value represented in OBNAME form (see Appendix B) and consisting of the Origin reference k followed by a Copy Number j followed by an Identifier. Examples are

  1&0&5‘Depth
  (Origin = 1, Copy Number = 0, Object Identifier = Depth)

  0&1&8‘Porosity
  (Origin = 0, Copy Number = 1, Object Identifier = Porosity)

- 3. The word "null" denotes a value comprising all bits zero in the minimum number of bytes permitted by a given Representation Code. Since the equivalent of a null value depends on its Representation Code, the word "null" is used when a Representation Code is not explicitly stated.

- 4. The notation 0‘ denotes the null ASCII or IDENT value, i.e., a zero-length string represented as a single byte containing the value zero.

- 5. When a bit is specified to be "reserved", then it must be recorded as a zero bit (not set).

3.2.2.1 Component Descriptor

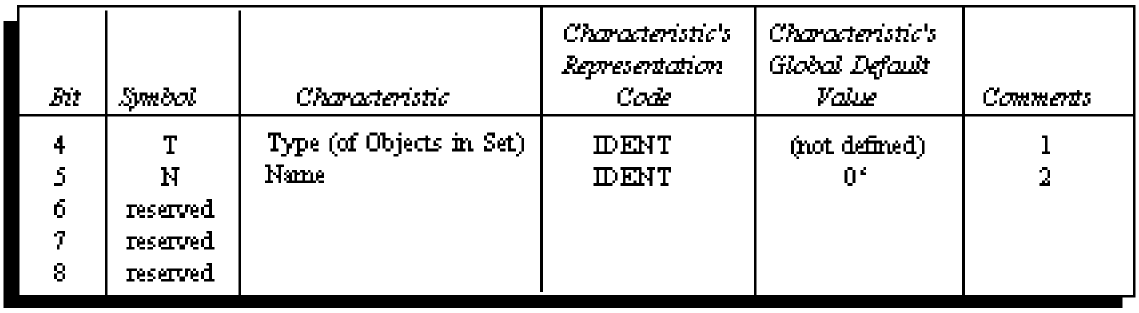
The first byte of every Component is its *Descriptor*. A Descriptor has two parts:

1. The Component *Role*. The Role indicates what type of entity is described by the Component.
   - The Component Role is defined in Figure 3-2. The symbolic names in the Role column of Figure 3-2 are used in illustrations later in this specification.
2. The Component *Format* as defined in Figures 3-3, 3-4, and 3-5.
   - The Format indicates which Characteristics of the entity represented by the Component are explicitly present in the remainder of the Component and the order in which they appear. Any Characteristic that is not explicitly present assumes a default value. A Characteristic is explicitly present in a Component if, and only if, the corresponding bit is set in the Component Format field. Characteristics appear in a Component in the same order in which they are defined in the Component Format field. That is, if bit 4 defines Characteristic A and bit 5 defines Characteristic
   - The Component Format is defined for Set, Redundant Set, and Replacement Set Components in Figure 3-3, for Object Components in Figure 3-4, and for Attribute and Invariant Attribute Components in Figure 3-5. The Absent Attribute has no Characteristics. Its Component Format field has all bits clear (not set).
   - The symbolic names in the Symbol column of the figures are used in illustrations later in this specification. Except for the Value Characteristic (Figure 3-5), all Characteristics have fixed Representation Codes. That is, when a given Characteristic is present in a Component, it is always represented in the same way. These representations are specified in the figures. Characteristics may have global default values, also specified in the figures. The global default value is always assumed when no explicit or local default value (see §3.2.2.2) is provided.

It is possible for a Component to consist entirely of its Descriptor, in which case all Characteristics assume default values.

Bits 1-3	**Role**	**Type of Component**
000	ABSATR	Absent Attribute
001	ATTRIB	Attribute
010	INVATR	Invariant Attribute
011	OBJECT	Object
100	reserved	-
101	RDSET	Redundant Set
110	RSET	Replacement Set
111	SET	Set

Figure 3-2. Definition of Component Role



Bit	*Symbol*	*Characteristic*	*Characteristic's Representation Code*	*Characteristic's Global Default Value*	*Comments*
4	T	Type (of Objects in Set)	IDENT	(not defined)	1
5	N	Name	IDENT	0'	2
6	reserved				
7	reserved				
8	reserved				

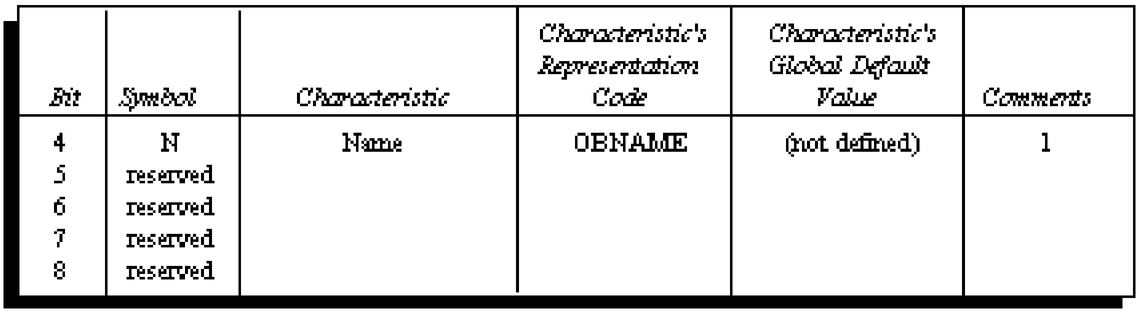
Figure 3-3. Definition of Characteristics and Component Format for Set, Redundant Set, and Replacement Set Components

Comments:

- 1. The *Type* Characteristic is a dictionary-controlled name that identifies the type of Objects contained in the Set (see Chapter 7). A Set's Type Characteristic is used to categorize the set of Attributes that apply to the Objects in the Set. A Set’s Type Characteristic must be non-null and must always be explicitly present in the Set Component. There is no global default.

  All Sets have the same structure, and Sets do not have "types" that distinguish one from another in that sense. Nevertheless, the phrase "Set Type" is used in this specification. It is a brief way to say "Set of Objects of Type ...". The phrase "Object Type" is also used in this specification. Objects do have types which distinguish one structure from another (i.e., available list of Attributes). The *Type* of an Object is specified by the Type Characteristic of the Set to which the Object belongs.

- 2. The *Name* Characteristic is a user-supplied name that identifies the Set. The phrases "Set Name" and "Set Name Characteristic" are used interchangeably.



Bit	*Symbol*	*Characteristic*	*Characteristic's Representation Code*	*Characteristic's Global Default Value*	*Comments*
4	N	Name	OBNAME	(not defined)	1
5	reserved				
6	reserved				
7	reserved				
8	reserved				

Figure 3-4. Definition of Characteristics and Component Format for Object Components

Comments:

- 1. The *Name* Characteristic identifies the Object. For certain Object Types, the Identifier Subfield of this name is dictionary-controlled. For other Object Types it is arbitrary. The phrases "Object Name" and "Object Name Characteristic" are used interchangeably. This Characteristic must always be present and must contain a non-null Identifier, so there is no global default value. That is, every Object has a non-null Name.

Bit	*Symbol*	*Characteristic*	*Characteristic's Representation Code*	*Characteristic's Global Default Value*	*Comments*
4	L	Label	IDENT	0'	1
5	C	Count	UVARI	1	2
6	R	Representation Code	USHORT	IDENT	2
7	U	Units	UNITS	0'	2
8	V	Value	(see comment)	null	2

Figure 3-5. Definition of Characteristics and Component Format for Attribute and Invariant Attribute Components

Comments:

- 1. The *Label* Characteristic is a dictionary-controlled name that identifies the Attribute. The phrases "Attribute Label", "Attribute Name", and "Attribute Label Characteristic" are used interchangeably for both Attribute Components and Invariant Attribute Components.
- 2. The *Count*, *Representation Code*, *Units*,; and *Value* Characteristics are closely related. A Value consists of zero or more ordered *Elements*. Each Element has the same Representation Code, specified by the value of the Representation Code Characteristic, and the same physical units of measurement, specified by the Units Characteristic. The number of Elements that make up the Value is specified by the Count Characteristic. The Count Characteristic may be zero. In this case, the Value Characteristic is undefined, i.e., it is an *Absent Value*.
  Note that although the Representation Code Characteristic is always represented in a Component as a USHORT (one-byte unsigned integer), the global default value for this Characteristic is the numeric code denoted by the symbol IDENT (see Appendix B).
  The phrases "Attribute Count" and "Attribute Count Characteristic" are used interchangeably, as are "Attribute Value" and "Attribute Value Characteristic", as are "Attribute Representation Code" and "Attribute Representation Code Characteristic", as are "Attribute Units" and "Attribute Units Characteristic".

3.2.2.2 Component Usage

This paragraph defines the usage of Components. Illustrations of how Components can be combined to form a Set are provided in later sections.

A *Set Component* defines the beginning of a Set and must be the first Component in the EFLR. The Set Component contains the Set Type, which is not optional and must not be null, and the Set Name, which is optional.

A Set consists of one or more Objects, preceded by a Template. The Objects in a Set share a common set of Attributes. The order and default Characteristics for these Attributes are defined in the Template. The Template immediately follows the Set Component and is terminated by an Object Component. A Template consists of a collection of Attribute Components and/or Invariant Attribute Components, mixed in any fashion. These Components define the structure of the Objects in the Set.

An *Object Component* defines the beginning of a new Object. The Object Component contains the Object Name, which is mandatory. Following the Object Component are a sequence of Attribute Components and possibly some Absent Attribute Components. An Object's Attribute Components are terminated by the end of the Logical Record or by the occurrence of another Object Component.

All Components in the Template must have distinct, non-null Labels. Attribute Components in the Template specify local default Characteristics for all Objects in the Set. Characteristics not present in Template Attribute Components assume the global default values defined in Figure 3-5. Invariant Attribute Components, which may only appear in the Template, represent *Invariant Attributes*, i.e., Attributes that are invariant in all Characteristics for all Objects in the Set. Therefore, Attribute Components corresponding to these Invariant Attributes need not and must not appear after Object Components.

All Attributes in the same "column" of a Set must have the same Attribute Label, namely, the one specified in the Template Attribute Component. Therefore, Attribute Components that follow Object Components must not have Attribute Labels. The remaining Characteristics may be freely specified by an Object's Attribute Components. Any Characteristic not present assumes the local default value as specified in the corresponding Attribute Component in the Template.

Missing Attribute Components imply that local defaults should be used for the Characteristics of the corresponding Attribute. Since Attribute order is important within a Set, only trailing Attribute Components can be omitted.

An Attribute is considered to be *Absent* for an Object when its Attribute Component is replaced by an AbsentAttributeComponent. An Absent Attribute is one for which no information is provided, not even default meaning.

A Redundant Set is an identical copy of some Set written previously in the same Logical File, including the Set Name and Type. If a Redundant Set is has a null Name, then the Set of which it is a copy must be the only Set in the same Logical File of the same Type, excluding other Redundant Sets, preceding the given Redundant Set.

A Replacement Set has the same Type and (non-null) Name, the same Template, and the same Objects (none added, none deleted) in the same order as a Set written previously in the same Logical File. However, the Attributes of the Replacement Set reflect all updates that may have been applied since the original Set was written. A Replacement Set can be written anywhere in a Logical File following the original Set that it replaces. There may be any number of Replacement Sets for a given original Set.

3.2.3 EFLR: Examples

Two views are used to illustrate EFLRs: symbolic and syntactic. In a symbolic illustration, the EFLR is represented by a Logical Record Segment Header symbol followed by a stream of Component symbols followed by a Logical Record Segment Trailer symbol. The symbols used in these illustrations are defined in Figure 3-6.

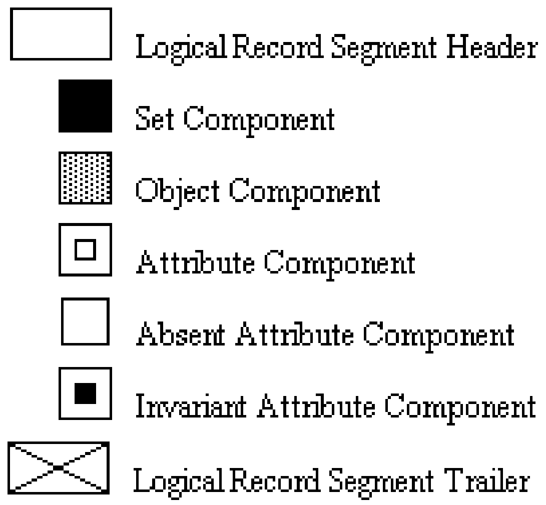

Logical Record Segment Header
Set Component
Object Component
Attribute Component
Absent Attribute Component
Invariant Attribute Component
Logical Record Segment Trailer

Figure 3-6. Symbolic Representation of Components

A syntactic illustration shows Component details, including explicit Characteristics and their values. The Component Descriptor is represented in the form **R:F**, where **R** is the Role, defined in Figure 3-2, and **F** is the concatenation of those symbols, defined in Figures 3-3 through 3-5, specifying which Format bits are set.

3.2.3.1 Symbolic Illustration of an EFLR

Figure 3-7 illustrates an EFLR, segmented into three Logical Record Segments. The segmentation is purely arbitrary and is done this way for illustrative purposes. Although the illustration shows segmentation on Component and Object boundaries, for example, this is not a requirement. Logical Record Segmentation may occur at any byte. The Order in which the Components are illustrated is from left to right, then top to bottom.

There are seven Attributes specified in the Template. One of these is an Invariant Attribute, so the column underneath it is left blank to indicate that no corresponding Attribute Components appear following the Object Components. The row for Object 3 contains an Absent Attribute Component, which means that the third Object has only six Attributes. For the second Object, on the other hand, the last three Attribute Components have been left out. This Object still has seven Attributes, but the last three are identical to the defaults defined in the Template.

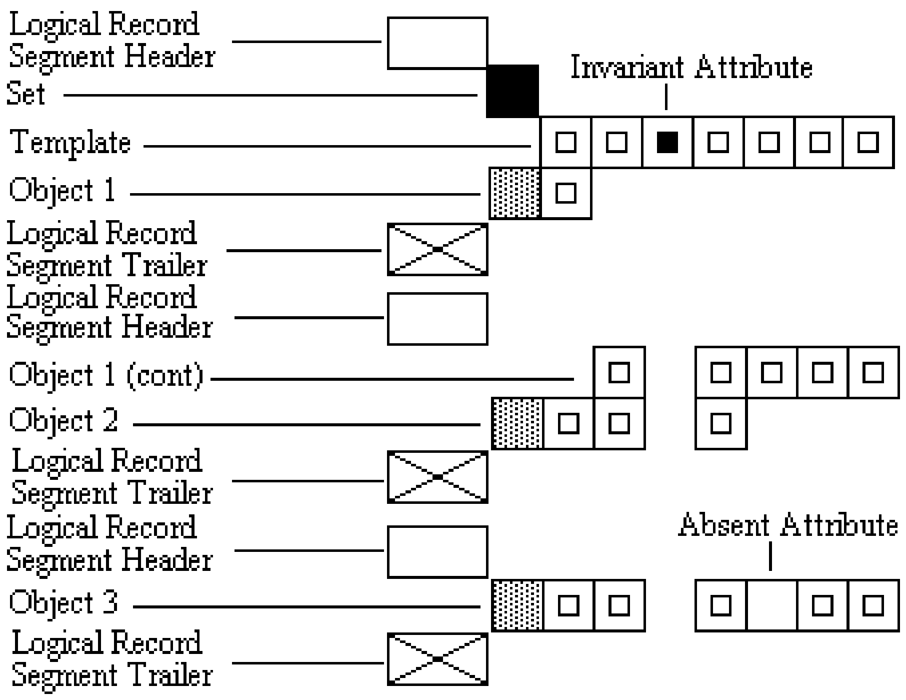

Logical Record Segment Header
Set
Invariant Attribute
Template
Object 1
Logical Record Segment Trailer
Logical Record Segment Header
Object 1 (cont)
Object 2
Logical Record Segment Trailer
Logical Record Segment Header
Absent Attribute
Object 3
Logical Record Segment Trailer

Figure 3-7. Symbolic Illustration of an EFLR

3.2.3.2 Syntactic Illustration of an EFLR

Figure 3-8 is a syntactic illustration of an EFLR. It illustrates a Set that spans three Logical Record Segments. This is a Set of Channel Objects (see Chapter 5). Detailed explanation of the entries in the figure is given in the comments that follow. To make the comments less awkward and more illustrative, some allusions are made to the semantic meanings of the Attributes shown in the example and of other entities. These comments are not intended to define any semantic meaning, since that is done in later chapters.

Also note that Attributes in the illustration appear in a different order from that used in Chapter 5 to define Channel Objects and not all Attributes are used. This emphasizes the fact that the order in which Attributes appear in the Template is arbitrary.

Entry	Size in Bytes	Hexadecimal Value	Comments
Logical Record Segment (#1) Header			
Length = 104 bytes	2	00 68	1
Attributes = 10100110	1	A6	2
Type = CHANNL	1	03	3
Channel Set			
SET:TN	1	F8	4
7'CHANNEL	8	07 43 48 41 4E 4E 45 4C	5
1'0	2	01 30	6
Template			
ATTRIB:LR	1	34	7
9'LONG-NAME	10	09 4C 4F 4E 47 2D 4E 41 4D 45	7
OBNAME	1	17	7
ATTRIB:LRV	1	35	8
13'ELEMENT-LIMIT	14	0D 45 4C 45 4D 45 4E 54 2D 4C 49 4D 49 54	8
UVARI	1	12	8
1	1	01	8
ATTRIB:LRV	1	35	9
19'REPRESENTATION- CODE	20	13 52 45 50 52 45 53 45 4E 54 41 54 49 4F 4E 2D 43 4F 44 45	9 9
USHORT	1	0F	9
FSINGL	1	02	9
ATTRIB:L	1	30	10
5'UNITS	6	05 55 4E 49 54 53	10
ATTRIB:LRV	1	35	11
9'DIMENSION	10	09 44 49 4D 45 4E 53 49 4F 4E	11
UVARI	1	12	11
1	1	01	11
Object #1			
OBJECT:N	1	70	12
0&0&4'TIME	7	00 00 04 54 49 4D 45	12
ATTRIB:V	1	21	13
0&0&1'1	4	00 00 01 31	13
Logical Record Segment Trailer			
checksum	2	xx xx	14
Trailing Length = 104 bytes	2	00 68	15

Figure 3-8. Syntactic Illustration of an EFLR

Entry	Size in Bytes	Hexadecimal Value	Comments
Logical Record Segment (#2) Header			

Length = 38 bytes
Attributes = 11100110
Type = CHANNL
	2
	1
	1
		00 26
		E7
		03
			1
			2a
			3

Continuation of Object #1			
ATTRIB:	1	20	16
ATTRIB:	1	20	17
ATTRIB:V 1‘s	1 2	21 01 73	18 18
Object #2			
OBJECT:N 1&0&8‘PRESSURE	1 11	70 01 00 08 50 52 45 53 53 55 52 45	12 12
ATTRIB:V 0&0&1‘2	1 4	21 00 00 01 32	13a 13a
ATTRIB:	1	20	16a
ATTRIB:V FDOUBL	1 1	21 07	17a 17a
ATTRIB:V 3‘psi	1 4	21 03 70 73 69	18a 18a
Logical Record Segment Trailer			
checksum Trailing Length = 38 bytes	2 2	xx xx 00 26	14 15

Figure 3-8 (cont). Syntactic Illustration of an EFLR

Entry	Size in Bytes	Hexadecimal Value	Comments
Logical Record Segment (#3) Header			

Length = 38 bytes
Attributes = 11000111
Type = CHANNL
	2
	1
	1
		00 26
		C7
		03
			1
			2b
			3

Object #3			
OBJECT:N 0&1&9‘PAD-ARRAY	1 12	70 00 01 09 50 41 44 2D 41 52 52 41 59	12 12
ATTRIB:V 0&0&1‘3	1 4	21 00 00 01 33	13b 13b
ATTRIB:CV 2 8 20	1 1 2	29 02 08 14	16b 16b 16b
ATTRIB:V UNORM	1 1	21 0D	17b 17b
ABSATR:	1	00	18b
ATTRIB:CV 2 8 10	1 1 2	29 02 08 0A	20b 20b 20b
Logical Record Segment Trailer			
Pad Count = 1 checksum Trailing Length = 38 bytes	1 2 2	01 xx xx 00 26	19 14 15

Figure 3-8 (cont). Syntactic Illustration of an EFLR

Comments:

- 1. Each EFLR begins with a length, which includes the LRSH, the LRB, and the LRST.
- 2. The Logical Record Segment Attribute bits for Segment #1 indicate an EFLR structure (bit 1), no predecessor segment (bit 2), a successor segment (bit 3), no encryption (bit 4), no Encryption Packet (bit 5), a checksum (bit 6), a Trailing Length (bit 7), and no Padding (bit 8).

- 2a. The Logical Record Segment Attribute bits for Segment #2 indicate an EFLR structure (bit 1), a predecessor segment (bit 2), a successor segment (bit 3), no encryption (bit 4), no Encryption Packet (bit 5), a checksum (bit 6), a Trailing Length (bit 7), and no Padding (bit 8).
- 2b. The Logical Record Segment Attribute bits for Segment #3 indicate an EFLR structure (bit 1), a predecessor segment (bit 2), no successor segment (bit 3), no encryption (bit 4), no Encryption Packet (bit 5), a checksum (bit 6), a Trailing Length (bit 7), and Padding (bit 8).
- 3. All Segments specify the same Logical Record Type, denoted by the term CHANNL. The numeric value (03) is obtained from Appendix A
- 4. The Set Component indicates presence of a Type and a Name.
- 5. The Object Type is CHANNEL (see Chapter 5).
- 6. The Set Name is "0".
- 7. Template Component #1 specifies the Attribute labelled Long-Name and its local default Representation Code = OBNAME. The remaining defaults (Count = 1, Units = 0‘, and Value = null) are taken from the global defaults specified in Figure 3-5.
- 8. Template Component #2 specifies the Attribute labelled Element-Limit, its local default Representation Code = UVARI, and its local default Value = 1. The global default Count = 1 is assumed. Thus, the local defaults indicate a scalar sample.
- 9. Template Component #3 specifies the Attribute labelled Representation-Code and its local default Representation Code = USHORT and Value = FSINGL. Note that the Value of this Attribute is a Representation Code, which semantically is applied to some other entity, in this case to the sample elements of some Channel.
- 10. Template Component #4 specifies the Attribute labelled Units. It does not explicitly specify any other Characteristics, so global defaults apply.
- 11. Template Component #5 specifies the Attribute labelled Dimension and its local default Representation Code = UVARI and Value = 1. The global default Count = 1 is assumed.
- 12. The Object Component for Object #1 precedes its own Attribute Components and terminates the Template. The Object Component for Object #2 precedes its own Attribute Components and terminates the Attribute Components of Object #1. The Object Component for Object #3 precedes its own Attribute Components and terminates the Attribute Components for Object #2.
  These Objects are named, respectively, "Time" (with Origin 0, Copy Number 0), "Pressure" (with Origin 1, Copy Number 0), and "Pad-Array" (with Origin 0, Copy Number 1).
- 13. The Long-Name Attribute for Object #1 references the Object named "1" from Origin 0 with Copy Number 0. The Type of the referenced Object (namely, Long-Name) is specified by definition for this Attribute.
- 13a. The Long-Name Attribute for Object #2 references the Object named "2" from Origin 0 with Copy Number 0.
- 13b. The Long-Name Attribute for Object #3 references the Object named "3" from Origin 0 with Copy Number 0.
- 14. Each Logical Record Segment Trailer contains a two-byte checksum.
- 15. Each Logical Record Segment Trailer contains a Trailing Length, which has a value equal to the Logical Record Segment Length in the LRSH.
- 16. The Element-Limit Attribute for Object #1 assumes all the local default Characteristics.
- 16a. The Element-Limit Attribute for Object #2 assumes all the local default Characteristics.
- 16b. The Element-Limit Attribute for Object #3 has Count = 2 and Value = {8 20}. This indicates that the corresponding sample value may be 1 or 2-dimensional, may have up to 8 array elements along the first dimension and up to 20 array elements along the second dimension.
- 17. The Representation-Code Attribute for Object #1 assumes all the local default Characteristics.
- 17a. The Representation-Code Attribute for Object #2 has the Value FDOUBL.
- 17b. The Representation-Code Attribute for Object #3 has the Value UNORM.
- 18. The Units Attribute for Object #1 has the Value s (second).
- 18a. The Units Attribute for Object #2 has the Value psi (pound per square inch).
- 18b. The Absent Attribute Component for Object #3 indicates that no Units Attribute is specified for this Object.
- 19. Padding is required in the third Logical Record Segment to make its length come out even. In this case, only one Padding Byte, the Pad Count, is required.
- 20. There is no Attribute Component for Object #1 for the Dimension Attribute. Therefore the Dimension Attribute assumes all the local default Characteristics.

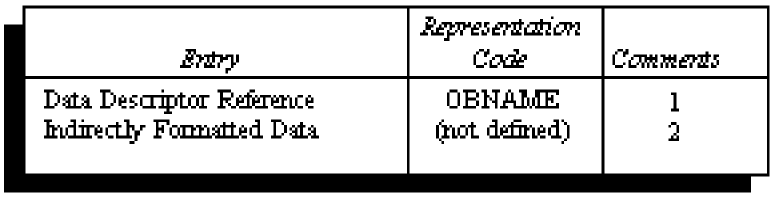
- 20a. There is no Attribute Component for Object #2 for the Dimension Attribute. Therefore the Dimension Attribute assumes all the local default Characteristics.
- 20b. The Dimension Attribute for Object #3 has Count = 2 and Value = {8 10}, i.e., a two-Element Value. The first Element is the integer 8 and the second Element is the integer 10. Semantically (as is specified in Chapter 5), this indicates that the samples of Channel Pad-Array (Copy 1) are 2-dimensional arrays with 8 elements in the first dimension and 10 in the second for a total of 80 elements.

3.3 Indirectly Formatted Logical Record

The format of the Logical Record Body of an Indirectly Formatted Logical Record cannot be interpreted from an analysis of the record itself. Instead, it is defined by the contents of associated EFLRs. Typically, a stream of data is encapsulated in a sequence of IFLRs. There can be several multiplexed sequences of IFLRs in a single Logical File. A referencing mechanism is used to sort them out. This characteristic is particularly useful for recording log data, which is acquired as a sequence of identically-formatted packets, the number of which is unknown by the system when acquisition begins.

3.3.1 IFLR: Specific Structure

Figure 3-9 defines the structure of the Logical Record Body of an Indirectly Formatted Logical Record.



Entry	*Representation Code*	*Comments*
Data Descriptor Reference	OBNAME	1
Indirectly Formatted Data	(not defined)	2

Figure 3-9. Structure of an Indirectly Formatted Logical Record

Comments:

- 1. The *Data Descriptor Reference* is the Name of an Object in an EFLR. The Logical Record Type in the Logical Record Segment Header must determine uniquely the Type of the Object that is referenced. The referenced Object and all other Objects that are used to define the format of the Indirectly Formatted Data must be in the same Logical File as this IFLR and must precede this IFLR.
- 2. The *Indirectly Formatted Data* is a set of 8-bit bytes, extending to the end of the Logical Record Body. This set contains the data. The specific format of this data is defined by the Object named in the Data Descriptor Reference and by any other Objects that are associated with that Object.