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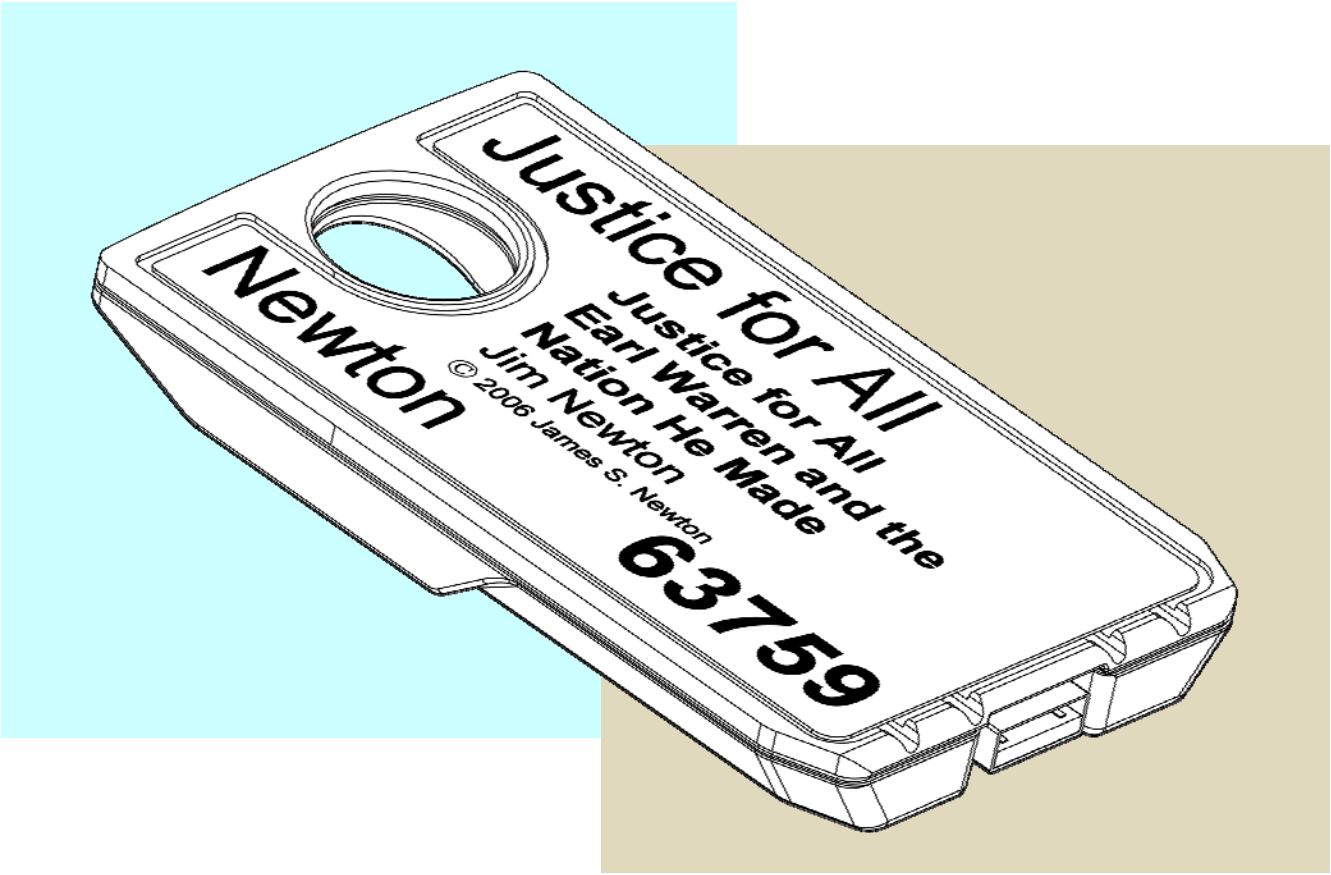
Specification 1150:2013

Digital Talking-Book Authoring Tool



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1. Scope

This specification defines the requirements for the development of digital talking-book authoring software. The application shall produce digital talking books (DTB) by recording live audio, and/or importing audio, encoding audio into the specified format, designating navigable elements, and compiling XML files that control the playback of DTBs in digital talking-book machines.

2. Reference Documents

The following documents and publications form a part of this specification. In the event of a conflict between the documents and publications referenced herein and the content of this specification, the content of this specification shall be considered a superseding requirement.

2.1 Specifications

American National Standards Institute (ANSI)

ANSI/NISO Z39.86-2002
Specifications for the Digital Talking Book

The document cited above is available from:

American National Standards Institute, Inc.
11 West 42nd Street
New York, NY 10036
Internet:
http://www.niso.org/standards/resources/Z39-86-2002.html

National Library Service for the Blind and Physically Handicapped

NLS Specification 1202:2011
Digital Talking-Book Mastering

NLS Specification 1203:2011
Construction of Digital Talking Books

The documents cited above are available from:

National Library Service for the Blind and Physically Handicapped
Library of Congress
1291 Taylor Street, NW
Washington, DC 20542
Internet:
http://www.loc.gov/nls/specs/

European Telecommunications Standards Institute

Extended Adaptive Multi-rate – Wideband (AMR-WB+) codec; Transcoding functions ETSI TS 126 290 release 6 / 3GPP TS 26.290 release 10

The document cited above is available from:

http://www.etsi.org/deliver/etsi_ts/126200_126299/126290/10.00.00_60/ts_126290v100000p.pdf

Transparent End-to-End Packet Switched Streaming Service; 3GPP file format (3GP) ETSI TS 126 244 release 7 / 3GPP TS 26.244 release 10

The document cited above is available from:

http://www.etsi.org/deliver/etsi_ts/126200_126299/126244/07.03.00_60/ts_126244v070300p.pdf

Internet Engineering Task Force Network Working Group

The MD5 Message-Digest Algorithm (RFC 1321, April 1992)

available at:
http://www.ietf.org/rfc/rfc1321.txt

2.2 Standards

Audio Engineering Society

AES17 -1998 (r2001)
AES standard method for digital audio engineering
Measurement of digital audio equipment

The document cited above is available from:
Audio Engineering Society
60 East 42nd Street, Room 2520
New York, NY 10165-2520
Internet:
http://www.aes.org/publications/standards/

International Electrotechnical Commission

IEC-60268-17
Sound System Equipment – Part 17: Standard Volume Indicators

IEC-60268-18
Sound System Equipment – Part 18: Peak Programme Level Meters – Digital Audio Peak Level Meter

The documents cited above is available from:
IEC Central Office
3 rue de Varemble
P.O. Box 131
1211 Geneva 20
Switzerland
Internet:
www.iec.ch

European Broadcast Union

Specification of the Broadcast WAVE Format

available at:
http://tech.ebu.ch/docs/tech/tech3285.pdf

Loudness Normalization and Permitted Maximum Level of Audio Signals EBU-R128

available at:
http://tech.ebu.ch/docs/r/r128.pdf

2.3 Definitions

Term	Acronym	Definition
Ancillary Audio File		The announcement and headings files that may be required to properly structure an NLS DTB compliant with Specification 1203:2011
Base Filename		An alphanumeric string that is common to all files in the DTB
Digital Audio Workstation	DAW	Computer-based audio recording and editing tool
Digital Talking Book	DTB	The complete set of files comprising a digital talking book as defined by NLS Specifications 1202:2011, 1203:2011, and ANSI/NISO Z39.86-2002
Digital Talking-Book Authoring Tool	DTB-AT	In this specification the terms “digital talking-book authoring tool” “application,” “program,” and “tool” are synonymous
Document Type Definition File	DTD	A file that contains machine-readable rules that define allowable XML markup for a particular application
Entity Reference File	ENT	List of character entities that may be incorporated in an XML file
Extended Adaptive Multi-Rate Wideband	AMR-WB+	An audio codec that is fully compliant with ETSI TS 126 244 release 7 and used in the final DTB and PDTB
MPEG-2 Audio Layer III	MP3	An audio codec compliant with the MPEG-2 standard and used as an alternative to the AMR-WB+ codec
Navigation Control File for XML Applications	NCX	A file compliant with ANSI/NISO Z39.86-2002, containing the hierarchical and optional list-based structures of a DTB
Open eBook Package File	OPF	A file compliant with ANSI/NISO Z39.86-2002, containing information about the DTB, the files that comprise it, and how the files interrelate
Pulse-code Modulation	PCM	Method used to digitally represent sampled analog signals
Primary Audio File		Main content audio file(s) needed to make a complete digital book
Project		Production in progress, from pre-production to rendering (exporting/building/compiling), synonyms: “session,” “book”
Render		Process of making a DTB including its audio and XML files; synonyms: export, master, bounce to disk
Root Mean Square	RMS	Measurement of the average signal level of a sine wave over a span of time
Synchronized Multimedia Integration Language	SMIL	A file compliant with ANSI/NISO Z39.86-2002 defining the sequence of playback audio objects that make up a DTB
Source Audio		Raw audio files of the un-rendered DTB synonyms: imported audio, recorded audio, project files, regions
Unique Identifier	UID	String of alphanumeric characters that distinguishes the distribution network, the source of the DTB, the type of DTB, and contains the DTB number. The UID can include the base file name for the DTB files.
User		The user of the DTB authoring tool (not the NLS patron)
Waveform Audio File Format	WAV	A linear PCM file as described in European Broadcasting Union Technical Specification 3285 appendix A
3GPP File Format	3GP	A multimedia container format compliant with ETSI TS 126 244 release 7 and used to in the final DTB and PDTB

3. Requirements

The following section outlines the requirements for a DTB authoring tool that is capable of producing fully functional DTBs according to the NLS Specifications 1202:2011, 1203:2011, and ANSI/NISO Z39.86-2002.

3.1 Compatibility

The program shall be a Windows executable, which shall run on all unaltered, fully updated versions of Windows 7 and Windows 8. Specifically:

- It must not require the purchase or installation of additional software other than freely available Microsoft components (e.g., the Java Runtime Environment or Java Development Toolkit).

3.2 Digital Audio Workstation (DAW) Capabilities

The program shall be a standard Digital Audio Workstation (DAW) capable of producing monophonic or stereophonic audio files. This section outlines the capabilities that shall be incorporated in the program for the creation of the audio files that comprise a DTB.

3.2.1 General Features

The program shall support any Windows Audio Session API (WASAPI) compatible audio interface.

The program shall have the ability to record and play back digital audio with any connected audio interface.

The program shall include the following audio editing capabilities:

- Waveform Display Workspace
- Auto-Backup
- Undo
- Audio Cut, Copy, and Paste
- Insert Silence/Space
- Signal Processing such as Equalization, Compression, Normalization, and Gain
- Go-to time controls
- Play modes such as Play/Pause and Play/Stop
- Location Markers (simple markers to locations in a session, not part of DTB production)

3.2.2 Specific DAW Features for Audiobook Production

3.2.2.1 Base Filename

The user shall be able to define a base filename that shall be pre-pended to the project audio and data filenames to create the specific filenames of the DTB. The base filename will serve the same function as the five-digit book number referenced in section 3.2.1.1 of NLS Specification 1203:2011. The base filename can be any alphanumeric combination of any length up to 50 characters.

3.2.2.2 Waveform Display Magnification/Zoom

The program shall have the ability to control the waveform display magnification, zoom in and zoom out, using a standard mouse scroll wheel, graphical user interface buttons, and keyboard shortcuts. The full waveform shall be displayed at one extreme and approximately 20 samples at the other.

3.2.2.3 Time Ruler

The program shall have a ruler that displays the time within the waveform workspace window. The ruler resolution shall vary based on the zoom magnification of the waveform display up to a resolution of approximately 2 milliseconds.

3.2.2.4 Metering

The program shall display input and playback meters compliant with EBU-R128 within the waveform workspace window.

The program shall display input and playback meters compliant with IEC-60268-18 (PPM) within the waveform workspace window.

The programs shall display input and playback meters compliant with IEC-60268-17 (VU) within the waveform workspace window.

The user shall have the option to choose between the above meters for use in the waveform display.

3.2.2.5 Analysis

The program shall have the ability to analyze and report the following statistics of a given file, or selection of a file: the values for RMS and the values and location of peak level(s).

3.2.2.6 Status Indicator

The program shall have the ability to control a MIDI-based cue light used to indicate standby and recording in progress.

3.2.2.7 Pre-Roll into Auto Punch-In

The program should have the ability to use pre-roll, of a varying length, into an automatic punch-in to record.

3.2.2.8 Undo

The program shall have the ability to undo the previous edit of the audio or DTB structure. This function can be performed repeatedly until the state of the project matches the most recent user-saved version.

3.2.2.9 Variable-Speed Playback

The program shall have the ability to playback at a variable rate up to at least 2 times the normal rate.

3.2.3 Audio Files

The default session parameters for recording shall be linear PCM data in WAV-file format at a sample rate of 44.1kHz, 16 bits per sample, block alignment = 2.

3.2.3.1 Conversion

The program shall have the ability to import PCM WAV files, MP3, and 3GP files containing AMR-WB+ into a session and shall be able to convert the imported files into PCM at the sample rate of the project.

3.2.3.2 File Limit

The maximum number of source audio files for a project shall not be fewer than 300.

3.3 DTB Production Controls

The tool shall create DTBs conforming to the normative requirements of ANSI/NISO Z39.86-2002. The following section details the specific functions and controls of the tool for the creation of DTBs according to the requirements of the NLS specifications 1202:2011 and 1203:2011. These controls shall allow the user to create DTB navigation elements, import data from existing projects or files into the current project,

and edit XML metadata. All controls shall be accessible from the GUI menu and with associated keyboard shortcuts.

3.3.1 Unique Identifier (UID)

The user shall be able to set a UID for the DTB as defined by section 3.1 of ANSI/NISO Z39-86.2002 and sections 3.2.1.2 and 3.2.5.2.1 of NLS Specification 1203:2011.

3.3.2 docTitle and/or docAuthor

The user shall be able to designate a section of audio as `<docTitle>` and/or `<docAuthor>` as defined in section 3.2.4.4 and 3.2.4.5 of NLS Specification 1203:2011.

3.3.3 Headings File

The `<docTitle>`, `<docAuthor>`, and all NCX navPoints and navTargets shall point to audio clips found in a headings file as defined by section 3.2.4.2 of NLS Specification 1203:2011. The controls for creating a navPoint and navTarget shall take user-selected portions of audio from the source files as a reference for creating the headings file.

3.3.4 Creation of Navigation Elements

The controls for creating DTB navigation elements shall create SMIL and NCX elements as defined in sections 3.2.3 and 3.2.4 of NLS Specification 1203:2011. All NCX navigation elements shall have corresponding SMIL elements as per section 3.2.3.10 of NLS Specification 1203:2011. The values of attributes shall be set automatically when possible based on the user-selected audio. The user shall be prompted to enter information for those values that cannot be automatically set. The program shall have the capability to explicitly create the following navigation elements:

3.3.4.1 NCX navPoint

NCX navPoints as defined in sections 3.2.4.3.1 and 3.2.4.7 of NLS Specification 1203:2011.

3.3.4.2 NCX navTarget

NCX navTargets as defined in sections 3.2.4.3.2 and 3.2.4.8 of NLS Specification 1203:2011.

3.3.4.3 SMIL Point (Segments)

SMIL Points shall create segments as defined in section 3.2.3.12 of NLS Specification 1203:2011.

Note: When a SMIL point is set it shall modify the end time of the SMIL element immediately proceeding to the time of SMIL point insertion. The clipEnd time of the SMIL point shall be defined as the begin time of the next SMIL element.

3.3.4.4 SMIL Clip

SMIL clip with a class attribute of note, prodnote, or sidebar as defined in section 7.4 of ANSI/NISO Z39.86-2002.

Note: A SMIL clip will have a set clipBegin and clipEnd time based on the selected portion of audio. SMIL clips will not be rendered in the headings file nor have NCX elements.

3.3.5 Import OPF Data

The user shall have the ability to import dc:metadata and x:metadata from an existing OPF file. The following rules shall apply to importing OPF metadata:

1. A new project with no OPF file shall use all metadata available in the imported existing OPF file.

2. If the existing OPF file contains a blank or empty element the program shall retain the blank or empty element and shall not eliminate the element from the new project.

3. A project in which an OPF file has been created can import metadata from an outside existing OPF file. However, only blank or empty elements shall be populated with metadata from the imported file. Project metadata shall not be overwritten with values from the imported file.

3.3.6 Edit Metadata

The user shall have the ability to create and edit a project's OPF metadata, including the elements defined in section 3.2.5.2 of NLS Specification 1203:2011. The user shall be able to create new OPF x-metadata elements. All OPF dc-metadata and x-metadata elements must be accessible to the user from within the program for editing.

3.3.7 Auto-Markup from Audio Scan

The program shall have the ability to scan the source audio files and, based on user-defined settings, automatically designate a level 1 navPoint, as defined by sections 3.2.4.3.1 and 3.2.4.7 of NLS Specification 1203:2011. Auto-markup shall scan for two different sections of silence; one to indicate the clipBegin time and the other to indicate clipEnd time. Prior to rendering the user shall have the option to edit the nesting level and attributes of the automatically generated navPoints as well as any or all of the child elements and their attributes/values. The following rules apply to auto-mark up from audio scan:

1. The user shall be able to specify the signal level to define silence in the source audio files.

2. The user shall be able to specify the length of silence used to indicate the clipBegin time.

3. The clipBegin time shall be automatically set to the time of the first audio sample (non-silence) immediately following the silence.

4. The user shall be able to specify the length of silence used to indicate the clipEnd time.

5. The clipEnd time shall be set to the time of the last audio sample (non-silence) immediately preceding the silence.

6. The user shall be able to define the class attribute and text elements automatically applied to all navPoints generated by the auto-markup.

3.3.8 Excluded Audio

The program shall have the ability to mark portions of audio, of user-defined length, to be excluded from the SMIL file and therefore not audible when the DTB is played. The excluded audio shall not be deleted from the primary WAV file nor excluded from the compressed primary audio file.

3.4 Complete Digital Talking Book (DTB)

The program shall render the following files as the complete DTB. The files shall conform to the normative requirements of ANSI/NISO Z39-86.2002 and NLS specifications 1202:2011 and 1203:2011.

3.4.1 Audio Files

The source audio that is recorded by the program or imported shall be rendered into the DTB audio files as uncompressed PCM WAV files and compressed audio files. The primary and ancillary WAV files shall be the source files for the compressed primary and ancillary audio files. The user shall have the option to render the DTB with either AMR-WB+ or MP3 compression formats.

3.4.1.1 Headings WAV File

When rendering the headings file, the audio shall be copied (not removed) from the sections of source audio files designated as docTitle, docAuthor, NCX navPoints, and NCX navTargets as outlined in section 3.3.

The file name of the headings WAV file shall meet the requirements as defined in section 3.4.2 NLS Specification 1202:2011.

3.4.1.2 Primary WAV File(s)

The program shall render the main content of the DTB as primary WAV files. The default length of the primary WAV files shall be 90 minutes +0/-1 minute, except for the last primary WAV file in the sequence as defined by section 3.3.2 of NLS Specification 1202:2011. However the user shall have the option of changing the maximum length of the primary WAV files for a DTB.

The filename of the primary WAV file(s) shall be derived from the base filename pre-pended to a four digit sequence indicator beginning with -0001.

basefilename-xxxx.wav

3.4.1.3 AMR-WB+ Compression Requirements

The program shall have an AMR-WB+ compression option. The primary and ancillary WAV files shall be the source files for the AMR-WB+ compressor. The compressed files must reflect the relationship to the WAV files with the inclusion of the WAV file's MD5 checksum. The compression shall conform to the requirements of section 3.3.1 of NLS Specification 1203:2011.

The 3GP file format shall be used to store the compressed AMR-WB+ frames. The 3GP files will be fully compliant with ETSI TS 126 244 release 7.

The filenames of the compressed primary and ancillary audio files shall be rendered as defined by section 3.2.1.1 of NLS Specification 1203:2011

3.4.1.4 MP3 Compression Requirements

The program shall have an MP3 compression option. The primary and ancillary WAV files shall be the source files for the MP3 compressor. The MP3 codec used must be approved by NLS and must be capable of compression at a constant bit rate of at least 48 kbps.

The names of the compressed primary and ancillary audio files shall be rendered as defined by section 3.2.1.1 of NLS Specification 1203:2011, except in the case of the file extension which shall be MP3.

3.4.2 XML Files

The following files shall be included in the complete DTB as per section 3.2.10 of NLS Specification 1203:2011:

3.4.2.1 OPF File

A package file (.opf) shall be included in the complete DTB conforming to the normative requirements of section 3 of ANSI/NISO Z39.86-2002 and section 3.2.5 of NLS Specification 1203:2011.

3.4.2.2 SMIL File

A Synchronized Multimedia Integration Language file(s) (.smil) shall be included in the complete DTB conforming to the normative requirements of section 7 of ANSI/NISO Z39.86-2002 and sections 3.2.1.1 and 3.2.3 of NLS Specification 1203:2011.

The size of the SMIL files shall not exceed 100 kilobytes. All SMIL files with the exception of the last shall have as many elements as can be contained given the size limit above.

3.4.2.3 NCX File

A navigation control file (.ncx) shall be included in the complete DTB conforming to the normative requirements of section 8 of ANSI/NISO Z39.86-2002 and section 3.2.4 of NLS Specification 1203:2011.

3.4.2.4 DTB-Specific SMIL DTD

A DTB-specific SMIL DTD file (dtbsmil110.dtd) shall be included in the complete DTB conforming to the normative requirements of Appendix 2 of ANSI/NISO Z39.86-2002.

3.4.2.5 NCX DTD

An NCX DTD file (ncx110.dtd) shall be included in the complete DTB conforming to the normative requirements of Appendix 3 of ANSI/NISO Z39.86-2002.

3.4.2.6 OEB Package

An OEB Package file (oebpkg101.dtd) shall be included in the complete DTB. For the full specification OEBF package file see Appendix A (page 13).

3.4.2.7 Entity Reference (oeb1.ent)

An entity reference file (oeb1.ent) shall be included in the complete DTB. For the full specification ENT file see Appendix B (page 17).

4. Appendix A – OEB Package

```
<!--
    Document Type Definition for the Open eBook package version 1.0.1

    Version:  1.0.1
    Revision: 20010201-x

    Authors:  Steve DeRose <steven_derose@brown.edu>
              Gunter Hille <hille@abc.de>
              Ben Trafford <bent@exemplary.net>
              Garret Wilson <garret@globalmentor.com>

    Usage:
        <?xml version="1.0"?>
        <!DOCTYPE package
          PUBLIC "+//ISBN 0-9673008-1-9//DTD OEB 1.0.1 Package//EN"
          "http://openebook.org/dtds/oeb-1.0.1/oebpkg101.dtd">
        <package unique-identifier="foo">
          metadata
          manifest
          spine
          tours
          guide
        </package>

    References:
      Transitional XHTML 1.0 DTD at http://www.w3.org/TR/xhtml1/DTD/transitional.dtd
-->

<!-- ******** Character Mnemonic Entities ******** -->

<!-- OEB supports all XHTML mnemonics, but uses only one entity file. -->
<!ENTITY % OEBEntities PUBLIC "+//ISBN 0-9673008-1-9//DTD OEB 1.0 Entities//EN" "oeb1.ent">
%OEBEntities;

<!-- ******** Attribute Types ******** -->

<!-- LanguageCode: An RFC1766 language code. -->
<!ENTITY % LanguageCode "NMTOKEN">

<!-- URI: An RFC2396 Uniform Resource Identifier. -->
<!ENTITY % URI "CDATA">

<!-- ******** Common Attributes ******** -->

<!-- InternationalAttributes: Attributes for internationalization.
  xml:lang:     XML language code.
-->
<!ENTITY % InternationalAttributes
  "xml:lang %LanguageCode; #IMPLIED"
>

<!-- CoreAttributes: Most common attributes used by many elements.
  id:       ID unique to the entire document.
-->
<!ENTITY % CoreAttributes "id ID #IMPLIED">

<!-- CommonAttributes: Common attributes used by many elements.
  CoreAttributes:   Most common attributes.
  InternationalAttributes:         Internationalization attributes.
-->
<!ENTITY % CommonAttributes
  "%CoreAttributes;
  %InternationalAttributes;"
>

<!-- DCNamespaceAttribute: Attribute that declare the Dublin Core
  namespace. Used mostly on each <dc:XXX> element to accomodate XML
  parsers which require this unnecessarily. -->
<!ENTITY % DCNamespaceAttribute
```

```
  "xmlns:dc   %URI;   #FIXED  'http://purl.org/dc/elements/1.0/'"
>

<!-- ******** OEB Package Elements ******** -->

<!-- A package must have metadata, a manifest, and a spine,
        and optionally may include a tours and/or a guide section. -->
<!ELEMENT package     (metadata, manifest, spine, tours?, guide?)>
<!ATTLIST package
  %CommonAttributes;
  unique-identifier   IDREF   #REQUIRED
  xmlns         %URI;   #FIXED  "http://openebook.org/namespaces/oeb-package/1.0/"
>

<!-- The metadata section must have dc-metadata but may or may not
  include x-metadata. -->
<!ELEMENT  metadata   (dc-metadata, x-metadata?)>

<!-- These elements are optional in <dc-metadata>. -->
<!ENTITY % DCMetadataOptionalElements
  "dc:Contributor  | dc:Creator | dc:Subject | dc:Description
  | dc:Publisher |  dc:Date | dc:Type | dc:Format | dc:Source
  | dc:Language | dc:Relation | dc:Coverage | dc:Rights"
>

<!-- These are the optional and required elements of <dc-metadata>. -->
<!ENTITY % DCMetadataGeneralElements
  "%DCMetadataOptionalElements; | dc:Title |dc:Identifier"
>

<!-- A dc-metadata section must have a dc:Title and a
  dc:Identifier, and optionally other dc:XXX elements, all in any
  order. -->
<!ELEMENT dc-metadata ((%DCMetadataOptionalElements;)*,
  ((dc:Title, (%DCMetadataOptionalElements; | dc:Title)*,
    (dc:Identifier, (%DCMetadataGeneralElements;)*)) |
  (dc:Identifier, (%DCMetadataOptionalElements; | dc:Identifier)*,
    (dc:Title, (%DCMetadataGeneralElements;)*))))
>

<!ATTLIST dc-metadata
  %CommonAttributes;
  %DCNamespaceAttribute;
  xmlns:oebpackage    %URI; #FIXED "http://openebook.org/namespaces/oeb-package/1.0/"
>

<!-- A dc:Contributor element may optionally have a role and/or a file-as
  attribute. -->
<!ELEMENT dc:Contributor (#PCDATA)>
<!ATTLIST dc:Contributor
  %CommonAttributes;
  %DCNamespaceAttribute;
  role      NMTOKEN   #IMPLIED
  file-as   CDATA         #IMPLIED
>

<!ELEMENT dc:Title (#PCDATA)>
<!ATTLIST dc:Title
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Creator (#PCDATA)>
<!ATTLIST dc:Creator
  %CommonAttributes;
  %DCNamespaceAttribute;
  role      NMTOKEN   #IMPLIED
  file-as   CDATA     #IMPLIED
>

<!ELEMENT dc:Subject (#PCDATA)>
<!ATTLIST dc:Subject
  %CommonAttributes;
  %DCNamespaceAttribute;
```

```
>

<!ELEMENT dc:Description (#PCDATA)>
<!ATTLIST dc:Description
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Publisher (#PCDATA)>
<!ATTLIST dc:Publisher
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Date     (#PCDATA)>
<!ATTLIST dc:Date
  %CommonAttributes;
  %DCNamespaceAttribute;
  event NMTOKEN       #IMPLIED
>

<!ELEMENT dc:Type (#PCDATA)>
<!ATTLIST dc:Type
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Format (#PCDATA)>
<!ATTLIST dc:Format
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Identifier (#PCDATA)>
<!ATTLIST dc:Identifier
  %CommonAttributes;
  %DCNamespaceAttribute;
  scheme NMTOKEN #IMPLIED
>

<!ELEMENT dc:Source (#PCDATA)>
<!ATTLIST dc:Source
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Language (#PCDATA)>
<!ATTLIST dc:Language
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Relation (#PCDATA)>
<!ATTLIST dc:Relation
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Coverage  (#PCDATA)>
<!ATTLIST dc:Coverage
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!ELEMENT dc:Rights (#PCDATA)>
<!ATTLIST dc:Rights
  %CommonAttributes;
  %DCNamespaceAttribute;
>

<!-- The <x-metadata> element must have at least one <meta> element. -->
<!ELEMENT x-metadata (meta+)>
<!ATTLIST x-metadata %CommonAttributes;>
```

```
<!ELEMENT meta EMPTY>
<!ATTLIST meta
  %CommonAttributes;
  name      NMTOKEN   #REQUIRED
  content   CDATA     #REQUIRED
  scheme    CDATA     #IMPLIED
>

<!-- The manifest must contain one or more items. -->
<!ELEMENT manifest (item+)>
<!ATTLIST manifest %CommonAttributes;>

<!-- The CommonAttributes entity is not used here because in this case
  the "id" attribute is required. -->
<!ELEMENT item EMPTY>
<!ATTLIST item
  %InternationalAttributes;
        id            ID      #REQUIRED
        href          CDATA   #REQUIRED
        media-type    CDATA   #REQUIRED
        fallback      IDREF   #IMPLIED
>

<!-- The spine must contain one or more itemrefs. -->
<!ELEMENT spine       (itemref+)>
<!ATTLIST spine       %CommonAttributes;>

<!ELEMENT itemref     EMPTY>
<!ATTLIST itemref
  %CommonAttributes;
  idref IDREF   #REQUIRED
>

<!-- The tours element must have one or more tour elements. -->
<!ELEMENT tours       (tour+)>
<!ATTLIST tours       %CommonAttributes;>

<!-- Each tour of the set must contain at least one site. -->
<!ELEMENT tour (site+)>
<!ATTLIST tour
  %CommonAttributes;
  title CDATA   #REQUIRED
>

<!-- Each site in a tour must have a title and an href. -->
<!ELEMENT site EMPTY>
<!ATTLIST site
  %CommonAttributes;
  title   CDATA   #REQUIRED
  href    CDATA   #REQUIRED
>

<!-- The guide element must have one or more reference elements. -->
<!ELEMENT guide       (reference+)>
<!ATTLIST guide       %CommonAttributes;>

<!ELEMENT reference   EMPTY>
<!ATTLIST reference
  %CommonAttributes;
  type    NMTOKEN   #REQUIRED
  title   CDATA     #REQUIRED
  href    CDATA     #REQUIRED
>
```

5. Appendix B – Entity Reference

```
<!--
    Character entities for the Open eBook publication structure version 1.0.1

    Version:  1.0.1
    Revision: 20001122-x

    Authors:  Gunter Hille <hille@abc.de>
              Ben Trafford <bent@exemplary.net>
              Garret Wilson <garret@globalmentor.com>

    Usage:
        <!ENTITY % OEBEntities PUBLIC "+//ISBN 0-9673008-1-9//DTD OEB 1.0 Entities//EN" "oeb1.ent">
        %OEBEntities;

    References:
      This DTD fragment is merely a combination of the external entities included
        with XHTML 1.0.

      Transitional XHTML 1.0 DTD at http://www.w3.org/TR/xhtml1/DTD/transitional.dtd
      http://www.w3.org/TR/xhtml1/DTD/HTMLlat1x.ent
      http://www.w3.org/TR/xhtml1/DTD/HTMLspecialx.ent
      http://www.w3.org/TR/xhtml1/DTD/HTMLsymbolx.ent

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          Permission to copy in any form is granted for use with
          conforming SGML systems and applications as defined in
          ISO 8879, provided this notice is included in all copies.
-->

<!ENTITY nbsp   " " ><!-- no-break space = non-breaking space,
                                    U+00A0 ISOnum -->
<!ENTITY iexcl  "&#161;" ><!-- inverted exclamation mark,
                                    U+00A1 ISOnum -->
<!ENTITY cent   "&#162;" ><!-- cent sign,
                                    U+00A2 ISOnum -->
<!ENTITY pound  "&#163;" ><!-- pound sign,
                                    U+00A3 ISOnum -->
<!ENTITY curren "&#164;" ><!-- currency sign,
                                    U+00A4 ISOnum -->
<!ENTITY yen    "&#165;" ><!-- yen sign = yuan sign,
                                    U+00A5 ISOnum -->
<!ENTITY brvbar "&#166;" ><!-- broken bar = broken vertical bar,
                                    U+00A6 ISOnum -->
<!ENTITY sect   "&#167;" ><!-- section sign,
                                    U+00A7 ISOnum -->
<!ENTITY uml    "&#168;" ><!-- diaeresis = spacing diaeresis,
                                    U+00A8 ISOdia -->
<!ENTITY copy   "&#169;" ><!-- copyright sign,
                                    U+00A9 ISOnum -->
<!ENTITY ordf   "&#170;" ><!-- feminine ordinal indicator,
                                    U+00AA ISOnum -->
<!ENTITY laquo  "&#171;" ><!-- left-pointing double angle quotation mark
                                    = left pointing guillemet,
                                    U+00AB ISOnum -->
<!ENTITY not    "&#172;" ><!-- not sign,
                                    U+00AC ISOnum -->
<!ENTITY shy    "&#173;" ><!-- soft hyphen = discretionary hyphen,
                                    U+00AD ISOnum -->
<!ENTITY reg    "&#174;" ><!-- registered sign = registered trade mark sign,
                                    U+00AE ISOnum -->
<!ENTITY macr   "&#175;" ><!-- macron = spacing macron = overline
                                    = APL overbar,
                                    U+00AF ISOdia -->
<!ENTITY deg    "&#176;" ><!-- degree sign,
                                    U+00B0 ISOnum -->
<!ENTITY plusmn "&#177;" ><!-- plus-minus sign = plus-or-minus sign,
                                    U+00B1 ISOnum -->
<!ENTITY sup2   "&#178;" ><!-- superscript two = superscript digit two
                                    = squared,
                                    U+00B2 ISOnum -->
```

```
<!ENTITY sup3   "&#179;" ><!-- superscript three = superscript digit three
                                = cubed,
                                U+00B3 ISOnum -->
<!ENTITY acute  "&#180;" ><!-- acute accent = spacing acute,
                                U+00B4 ISOdia -->
<!ENTITY micro  "&#181;" ><!-- micro sign,
                                U+00B5 ISOnum -->
<!ENTITY para   "&#182;" ><!-- pilcrow sign = paragraph sign,
                                U+00B6 ISOnum -->
<!ENTITY middot "&#183;" ><!-- middle dot = Georgian comma
                                = Greek middle dot,
                                U+00B7 ISOnum -->
<!ENTITY cedil  "&#184;" ><!-- cedilla = spacing cedilla,
                                U+00B8 ISOdia -->
<!ENTITY sup1   "&#185;" ><!-- superscript one = superscript digit one,
                                U+00B9 ISOnum -->
<!ENTITY ordm   "&#186;" ><!-- masculine ordinal indicator,
                                U+00BA ISOnum -->
<!ENTITY raquo  "&#187;" ><!-- right-pointing double angle quotation mark
                                = right pointing guillemet,
                                U+00BB ISOnum -->
<!ENTITY frac14 "&#188;" ><!-- vulgar fraction one quarter
                                = fraction one quarter,
                                U+00BC ISOnum -->
<!ENTITY frac12 "&#189;" ><!-- vulgar fraction one half
                                = fraction one half,
                                U+00BD ISOnum -->
<!ENTITY frac34 "&#190;" ><!-- vulgar fraction three quarters
                                = fraction three quarters,
                                U+00BE ISOnum -->
<!ENTITY iquest "&#191;" ><!-- inverted question mark
                                = turned question mark,
                                U+00BF ISOnum -->
<!ENTITY Agrave "&#192;" ><!-- latin capital letter A with grave
                                = latin capital letter A grave,
                                U+00C0 ISOlat1 -->
<!ENTITY Aacute "&#193;" ><!-- latin capital letter A with acute,
                                U+00C1 ISOlat1 -->
<!ENTITY Acirc  "&#194;" ><!-- latin capital letter A with circumflex,
                                U+00C2 ISOlat1 -->
<!ENTITY Atilde "&#195;" ><!-- latin capital letter A with tilde,
                                U+00C3 ISOlat1 -->
<!ENTITY Auml   "&#196;" ><!-- latin capital letter A with diaeresis,
                                U+00C4 ISOlat1 -->
<!ENTITY Aring  "&#197;" ><!-- latin capital letter A with ring above
                                = latin capital letter A ring,
                                U+00C5 ISOlat1 -->
<!ENTITY AElig  "&#198;" ><!-- latin capital letter AE
                                = latin capital ligature AE,
                                U+00C6 ISOlat1 -->
<!ENTITY Ccedil "&#199;" ><!-- latin capital letter C with cedilla,
                                U+00C7 ISOlat1 -->
<!ENTITY Egrave "&#200;" ><!-- latin capital letter E with grave,
                                U+00C8 ISOlat1 -->
<!ENTITY Eacute "&#201;" ><!-- latin capital letter E with acute,
                                U+00C9 ISOlat1 -->
<!ENTITY Ecirc  "&#202;" ><!-- latin capital letter E with circumflex,
                                U+00CA ISOlat1 -->
<!ENTITY Euml   "&#203;" ><!-- latin capital letter E with diaeresis,
                                U+00CB ISOlat1 -->
<!ENTITY Igrave "&#204;" ><!-- latin capital letter I with grave,
                                U+00CC ISOlat1 -->
<!ENTITY Iacute "&#205;" ><!-- latin capital letter I with acute,
                                U+00CD ISOlat1 -->
<!ENTITY Icirc  "&#206;" ><!-- latin capital letter I with circumflex,
                                U+00CE ISOlat1 -->
<!ENTITY Iuml   "&#207;" ><!-- latin capital letter I with diaeresis,
                                U+00CF ISOlat1 -->
<!ENTITY ETH    "&#208;" ><!-- latin capital letter ETH,
                                U+00D0 ISOlat1 -->
<!ENTITY Ntilde "&#209;" ><!-- latin capital letter N with tilde,
                                U+00D1 ISOlat1 -->
<!ENTITY Ograve "&#210;" ><!-- latin capital letter O with grave,
                                U+00D2 ISOlat1 -->
```

```
<!ENTITY Oacute "&#211;" ><!-- latin capital letter O with acute,
                                    U+00D3 ISOlat1 -->
<!ENTITY Ocirc  "&#212;" ><!-- latin capital letter O with circumflex,
                                    U+00D4 ISOlat1 -->
<!ENTITY Otilde "&#213;" ><!-- latin capital letter O with tilde,
                                    U+00D5 ISOlat1 -->
<!ENTITY Ouml   "&#214;" ><!-- latin capital letter O with diaeresis,
                                    U+00D6 ISOlat1 -->
<!ENTITY times  "&#215;" ><!-- multiplication sign,
                                    U+00D7 ISOnum -->
<!ENTITY Oslash "&#216;" ><!-- latin capital letter O with stroke
                                    = latin capital letter O slash,
                                    U+00D8 ISOlat1 -->
<!ENTITY Ugrave "&#217;" ><!-- latin capital letter U with grave,
                                    U+00D9 ISOlat1 -->
<!ENTITY Uacute "&#218;" ><!-- latin capital letter U with acute,
                                    U+00DA ISOlat1 -->
<!ENTITY Ucirc  "&#219;" ><!-- latin capital letter U with circumflex,
                                    U+00DB ISOlat1 -->
<!ENTITY Uuml   "&#220;" ><!-- latin capital letter U with diaeresis,
                                    U+00DC ISOlat1 -->
<!ENTITY Yacute "&#221;" ><!-- latin capital letter Y with acute,
                                    U+00DD ISOlat1 -->
<!ENTITY THORN  "&#222;" ><!-- latin capital letter THORN,
                                    U+00DE ISOlat1 -->
<!ENTITY szlig  "&#223;" ><!-- latin small letter sharp s = ess-zed,
                                    U+00DF ISOlat1 -->
<!ENTITY agrave "&#224;" ><!-- latin small letter a with grave
                                    = latin small letter a grave,
                                    U+00E0 ISOlat1 -->
<!ENTITY aacute "&#225;" ><!-- latin small letter a with acute,
                                    U+00E1 ISOlat1 -->
<!ENTITY acirc  "&#226;" ><!-- latin small letter a with circumflex,
                                    U+00E2 ISOlat1 -->
<!ENTITY atilde "&#227;" ><!-- latin small letter a with tilde,
                                    U+00E3 ISOlat1 -->
<!ENTITY auml   "&#228;" ><!-- latin small letter a with diaeresis,
                                    U+00E4 ISOlat1 -->
<!ENTITY aring  "&#229;" ><!-- latin small letter a with ring above
                                    = latin small letter a ring,
                                    U+00E5 ISOlat1 -->
<!ENTITY aelig  "&#230;" ><!-- latin small letter ae
                                    = latin small ligature ae,
                                    U+00E6 ISOlat1 -->
<!ENTITY ccedil "&#231;" ><!-- latin small letter c with cedilla,
                                    U+00E7 ISOlat1 -->
<!ENTITY egrave "&#232;" ><!-- latin small letter e with grave,
                                    U+00E8 ISOlat1 -->
<!ENTITY eacute "&#233;" ><!-- latin small letter e with acute,
                                    U+00E9 ISOlat1 -->
<!ENTITY ecirc  "&#234;" ><!-- latin small letter e with circumflex,
                                    U+00EA ISOlat1 -->
<!ENTITY euml   "&#235;" ><!-- latin small letter e with diaeresis,
                                    U+00EB ISOlat1 -->
<!ENTITY igrave "&#236;" ><!-- latin small letter i with grave,
                                    U+00EC ISOlat1 -->
<!ENTITY iacute "&#237;" ><!-- latin small letter i with acute,
                                    U+00ED ISOlat1 -->
<!ENTITY icirc  "&#238;" ><!-- latin small letter i with circumflex,
                                    U+00EE ISOlat1 -->
<!ENTITY iuml   "&#239;" ><!-- latin small letter i with diaeresis,
                                    U+00EF ISOlat1 -->
<!ENTITY eth    "&#240;" ><!-- latin small letter eth,
                                    U+00F0 ISOlat1 -->
<!ENTITY ntilde "&#241;" ><!-- latin small letter n with tilde,
                                    U+00F1 ISOlat1 -->
<!ENTITY ograve "&#242;" ><!-- latin small letter o with grave,
                                    U+00F2 ISOlat1 -->
<!ENTITY oacute "&#243;" ><!-- latin small letter o with acute,
                                    U+00F3 ISOlat1 -->
<!ENTITY ocirc  "&#244;" ><!-- latin small letter o with circumflex,
                                    U+00F4 ISOlat1 -->
<!ENTITY otilde "&#245;" ><!-- latin small letter o with tilde,
                                    U+00F5 ISOlat1 -->
```

```
<!ENTITY ouml   "&#246;" ><!-- latin small letter o with diaeresis,
                                    U+00F6 ISOlat1 -->
<!ENTITY divide "&#247;" ><!-- division sign,
                                    U+00F7 ISOnum -->
<!ENTITY oslash "&#248;" ><!-- latin small letter o with stroke,
                                    = latin small letter o slash,
                                    U+00F8 ISOlat1 -->
<!ENTITY ugrave "&#249;" ><!-- latin small letter u with grave,
                                    U+00F9 ISOlat1 -->
<!ENTITY uacute "&#250;" ><!-- latin small letter u with acute,
                                    U+00FA ISOlat1 -->
<!ENTITY ucirc  "&#251;" ><!-- latin small letter u with circumflex,
                                    U+00FB ISOlat1 -->
<!ENTITY uuml   "&#252;" ><!-- latin small letter u with diaeresis,
                                    U+00FC ISOlat1 -->
<!ENTITY yacute "&#253;" ><!-- latin small letter y with acute,
                                    U+00FD ISOlat1 -->
<!ENTITY thorn  "&#254;" ><!-- latin small letter thorn with,
                                    U+00FE ISOlat1 -->
<!ENTITY yuml   "&#255;" ><!-- latin small letter y with diaeresis,
                                    U+00FF ISOlat1 -->

<!-- C0 Controls and Basic Latin -->
<!ENTITY apos    "&#39;">

<!-- Latin Extended-A -->
<!ENTITY OElig   "&#338;" ><!-- latin capital ligature OE, U+0152 ISOlat2 -->
<!ENTITY oelig   "&#339;" ><!-- latin small ligature oe, U+0153 ISOlat2 -->

<!-- ligature is a misnomer, this is a separate character in some languages -->
<!ENTITY Scaron  "&#352;" ><!-- latin capital letter S with caron,
                                     U+0160 ISOlat2 -->
<!ENTITY scaron  "&#353;" ><!-- latin small letter s with caron,
                                     U+0161 ISOlat2 -->
<!ENTITY Yuml    "&#376;" ><!-- latin capital letter Y with diaeresis,
                                     U+0178 ISOlat2 -->

<!-- Spacing Modifier Letters -->
<!ENTITY circ    "&#710;" ><!-- modifier letter circumflex accent,
                                     U+02C6 ISOpub -->
<!ENTITY tilde   "&#732;" ><!-- small tilde, U+02DC ISOdia -->

<!-- General Punctuation -->
<!ENTITY ensp    " " ><!-- en space, U+2002 ISOpub -->
<!ENTITY emsp    " " ><!-- em space, U+2003 ISOpub -->
<!ENTITY thinsp  " " ><!-- thin space, U+2009 ISOpub -->
<!ENTITY zwnj    "&#8204;" ><!-- zero width non-joiner,
                                      U+200C NEW RFC 2070 -->
<!ENTITY zwj     "&#8205;" ><!-- zero width joiner, U+200D NEW RFC 2070 -->
<!ENTITY lrm     "&#8206;" ><!-- left-to-right mark, U+200E NEW RFC 2070 -->
<!ENTITY rlm     "&#8207;" ><!-- right-to-left mark, U+200F NEW RFC 2070 -->
<!ENTITY ndash   "&#8211;" ><!-- en dash, U+2013 ISOpub -->
<!ENTITY mdash   "&#8212;" ><!-- em dash, U+2014 ISOpub -->
<!ENTITY lsquo   "&#8216;" ><!-- left single quotation mark,
                                      U+2018 ISOnum -->
<!ENTITY rsquo   "&#8217;" ><!-- right single quotation mark,
                                      U+2019 ISOnum -->
<!ENTITY sbquo   "&#8218;" ><!-- single low-9 quotation mark, U+201A NEW -->
<!ENTITY ldquo   "&#8220;" ><!-- left double quotation mark,
                                      U+201C ISOnum -->
<!ENTITY rdquo   "&#8221;" ><!-- right double quotation mark,
                                      U+201D ISOnum -->
<!ENTITY bdquo   "&#8222;" ><!-- double low-9 quotation mark, U+201E NEW -->
<!ENTITY dagger  "&#8224;" ><!-- dagger, U+2020 ISOpub -->
<!ENTITY Dagger  "&#8225;" ><!-- double dagger, U+2021 ISOpub -->
<!ENTITY permil  "&#8240;" ><!-- per mille sign, U+2030 ISOtech -->

<!-- lsaquo is proposed but not yet ISO standardized -->
<!ENTITY lsaquo  "&#8249;" ><!-- single left-pointing angle quotation mark,
                                      U+2039 ISO proposed -->
<!-- rsaquo is proposed but not yet ISO standardized -->
<!ENTITY rsaquo  "&#8250;" ><!-- single right-pointing angle quotation mark,
                                      U+203A ISO proposed -->
<!ENTITY euro    "&#8364;" ><!-- euro sign, U+20AC NEW -->
```

```
<!-- Latin Extended-B -->
<!ENTITY fnof     "&#402;" ><!-- latin small f with hook = function
                              = florin, U+0192 ISOtech -->

<!-- Greek -->
<!ENTITY Alpha    "&#913;" ><!-- greek capital letter alpha, U+0391 -->
<!ENTITY Beta     "&#914;" ><!-- greek capital letter beta, U+0392 -->
<!ENTITY Gamma    "&#915;" ><!-- greek capital letter gamma, U+0393 ISOgrk3 -->
<!ENTITY Delta    "&#916;" ><!-- greek capital letter delta, U+0394 ISOgrk3 -->
<!ENTITY Epsilon  "&#917;" ><!-- greek capital letter epsilon, U+0395 -->
<!ENTITY Zeta     "&#918;" ><!-- greek capital letter zeta, U+0396 -->
<!ENTITY Eta      "&#919;" ><!-- greek capital letter eta, U+0397 -->
<!ENTITY Theta    "&#920;" ><!-- greek capital letter theta, U+0398 ISOgrk3 -->
<!ENTITY Iota     "&#921;" ><!-- greek capital letter iota, U+0399 -->
<!ENTITY Kappa    "&#922;" ><!-- greek capital letter kappa, U+039A -->
<!ENTITY Lambda   "&#923;" ><!-- greek capital letter lambda, U+039B ISOgrk3 -->
<!ENTITY Mu       "&#924;" ><!-- greek capital letter mu, U+039C -->
<!ENTITY Nu       "&#925;" ><!-- greek capital letter nu, U+039D -->
<!ENTITY Xi       "&#926;" ><!-- greek capital letter xi, U+039E ISOgrk3 -->
<!ENTITY Omicron  "&#927;" ><!-- greek capital letter omicron, U+039F -->
<!ENTITY Pi       "&#928;" ><!-- greek capital letter pi, U+03A0 ISOgrk3 -->
<!ENTITY Rho      "&#929;" ><!-- greek capital letter rho, U+03A1 -->
<!-- there is no Sigmaf, and no U+03A2 character either -->
<!ENTITY Sigma    "&#931;" ><!-- greek capital letter sigma, U+03A3 ISOgrk3 -->
<!ENTITY Tau      "&#932;" ><!-- greek capital letter tau, U+03A4 -->
<!ENTITY Upsilon  "&#933;" ><!-- greek capital letter upsilon,
                              U+03A5 ISOgrk3 -->
<!ENTITY Phi      "&#934;" ><!-- greek capital letter phi, U+03A6 ISOgrk3 -->
<!ENTITY Chi      "&#935;" ><!-- greek capital letter chi, U+03A7 -->
<!ENTITY Psi      "&#936;" ><!-- greek capital letter psi, U+03A8 ISOgrk3 -->
<!ENTITY Omega    "&#937;" ><!-- greek capital letter omega, U+03A9 ISOgrk3 -->
<!ENTITY alpha    "&#945;" ><!-- greek small letter alpha, U+03B1 ISOgrk3 -->
<!ENTITY beta     "&#946;" ><!-- greek small letter beta, U+03B2 ISOgrk3 -->
<!ENTITY gamma    "&#947;" ><!-- greek small letter gamma, U+03B3 ISOgrk3 -->
<!ENTITY delta    "&#948;" ><!-- greek small letter delta, U+03B4 ISOgrk3 -->
<!ENTITY epsilon  "&#949;" ><!-- greek small letter epsilon, U+03B5 ISOgrk3 -->
<!ENTITY zeta     "&#950;" ><!-- greek small letter zeta, U+03B6 ISOgrk3 -->
<!ENTITY eta      "&#951;" ><!-- greek small letter eta, U+03B7 ISOgrk3 -->
<!ENTITY theta    "&#952;" ><!-- greek small letter theta, U+03B8 ISOgrk3 -->
<!ENTITY iota     "&#953;" ><!-- greek small letter iota, U+03B9 ISOgrk3 -->
<!ENTITY kappa    "&#954;" ><!-- greek small letter kappa, U+03BA ISOgrk3 -->
<!ENTITY lambda   "&#955;" ><!-- greek small letter lambda, U+03BB ISOgrk3 -->
<!ENTITY mu       "&#956;" ><!-- greek small letter mu, U+03BC ISOgrk3 -->
<!ENTITY nu       "&#957;" ><!-- greek small letter nu, U+03BD ISOgrk3 -->
<!ENTITY xi       "&#958;" ><!-- greek small letter xi, U+03BE ISOgrk3 -->
<!ENTITY omicron  "&#959;" ><!-- greek small letter omicron, U+03BF NEW -->
<!ENTITY pi       "&#960;" ><!-- greek small letter pi, U+03C0 ISOgrk3 -->
<!ENTITY rho      "&#961;" ><!-- greek small letter rho, U+03C1 ISOgrk3 -->
<!ENTITY sigmaf   "&#962;" ><!-- greek small letter final sigma,
                              U+03C2 ISOgrk3 -->
<!ENTITY sigma    "&#963;" ><!-- greek small letter sigma, U+03C3 ISOgrk3 -->
<!ENTITY tau      "&#964;" ><!-- greek small letter tau, U+03C4 ISOgrk3 -->
<!ENTITY upsilon  "&#965;" ><!-- greek small letter upsilon,
                              U+03C5 ISOgrk3 -->
<!ENTITY phi      "&#966;" ><!-- greek small letter phi, U+03C6 ISOgrk3 -->
<!ENTITY chi      "&#967;" ><!-- greek small letter chi, U+03C7 ISOgrk3 -->
<!ENTITY psi      "&#968;" ><!-- greek small letter psi, U+03C8 ISOgrk3 -->
<!ENTITY omega    "&#969;" ><!-- greek small letter omega, U+03C9 ISOgrk3 -->
<!ENTITY thetasym "&#977;" ><!-- greek small letter theta symbol,
                              U+03D1 NEW -->
<!ENTITY upsih    "&#978;" ><!-- greek upsilon with hook symbol,
                              U+03D2 NEW -->
<!ENTITY piv      "&#982;" ><!-- greek pi symbol, U+03D6 ISOgrk3 -->

<!-- General Punctuation -->
<!ENTITY bull     "&#8226;" ><!-- bullet = black small circle,
                               U+2022 ISOpub  -->
<!-- bullet is NOT the same as bullet operator, U+2219 -->
<!ENTITY hellip   "&#8230;" ><!-- horizontal ellipsis = three dot leader,
                               U+2026 ISOpub  -->
<!ENTITY prime    "&#8242;" ><!-- prime = minutes = feet, U+2032 ISOtech -->
<!ENTITY Prime    "&#8243;" ><!-- double prime = seconds = inches,
                               U+2033 ISOtech -->
```

```
<!ENTITY oline    "&#8254;" ><!-- overline = spacing overscore,
                               U+203E NEW -->
<!ENTITY frasl    "&#8260;" ><!-- fraction slash, U+2044 NEW -->

<!-- Letterlike Symbols -->
<!ENTITY weierp   "&#8472;" ><!-- script capital P = power set
                               = Weierstrass p, U+2118 ISOamso -->
<!ENTITY image    "&#8465;" ><!-- blackletter capital I = imaginary part,
                               U+2111 ISOamso -->
<!ENTITY real     "&#8476;" ><!-- blackletter capital R = real part symbol,
                               U+211C ISOamso -->
<!ENTITY trade    "&#8482;" ><!-- trade mark sign, U+2122 ISOnum -->
<!ENTITY alefsym  "&#8501;" ><!-- alef symbol = first transfinite cardinal,
                               U+2135 NEW -->
<!-- alef symbol is NOT the same as hebrew letter alef,
     U+05D0 although the same glyph could be used to depict both characters -->

<!-- Arrows -->
<!ENTITY larr     "&#8592;" ><!-- leftwards arrow, U+2190 ISOnum -->
<!ENTITY uarr     "&#8593;" ><!-- upwards arrow, U+2191 ISOnum-->
<!ENTITY rarr     "&#8594;" ><!-- rightwards arrow, U+2192 ISOnum -->
<!ENTITY darr     "&#8595;" ><!-- downwards arrow, U+2193 ISOnum -->
<!ENTITY harr     "&#8596;" ><!-- left right arrow, U+2194 ISOamsa -->
<!ENTITY crarr    "&#8629;" ><!-- downwards arrow with corner leftwards
                               = carriage return, U+21B5 NEW -->
<!ENTITY lArr     "&#8656;" ><!-- leftwards double arrow, U+21D0 ISOtech -->
<!-- Unicode does not say that lArr is the same as the 'is implied by' arrow
    but also does not have any other character for that function. So ? lArr can
    be used for 'is implied by' as ISOtech suggests -->
<!ENTITY uArr     "&#8657;" ><!-- upwards double arrow, U+21D1 ISOamsa -->
<!ENTITY rArr     "&#8658;" ><!-- rightwards double arrow,
                               U+21D2 ISOtech -->
<!-- Unicode does not say this is the 'implies' character but does not have
     another character with this function so ?
     rArr can be used for 'implies' as ISOtech suggests -->
<!ENTITY dArr     "&#8659;" ><!-- downwards double arrow, U+21D3 ISOamsa -->
<!ENTITY hArr     "&#8660;" ><!-- left right double arrow,
                               U+21D4 ISOamsa -->

<!-- Mathematical Operators -->
<!ENTITY forall   "&#8704;" ><!-- for all, U+2200 ISOtech -->
<!ENTITY part     "&#8706;" ><!-- partial differential, U+2202 ISOtech  -->
<!ENTITY exist    "&#8707;" ><!-- there exists, U+2203 ISOtech -->
<!ENTITY empty    "&#8709;" ><!-- empty set = null set = diameter,
                               U+2205 ISOamso -->
<!ENTITY nabla    "&#8711;" ><!-- nabla = backward difference,
                               U+2207 ISOtech -->
<!ENTITY isin     "&#8712;" ><!-- element of, U+2208 ISOtech -->
<!ENTITY notin    "&#8713;" ><!-- not an element of, U+2209 ISOtech -->
<!ENTITY ni       "&#8715;" ><!-- contains as member, U+220B ISOtech -->
<!-- should there be a more memorable name than 'ni'? -->
<!ENTITY prod     "&#8719;" ><!-- n-ary product = product sign,
                               U+220F ISOamsb -->
<!-- prod is NOT the same character as U+03A0 'greek capital letter pi' though
     the same glyph might be used for both -->
<!ENTITY sum      "&#8721;" ><!-- n-ary sumation, U+2211 ISOamsb -->
<!-- sum is NOT the same character as U+03A3 'greek capital letter sigma'
     though the same glyph might be used for both -->
<!ENTITY minus    "&#8722;" ><!-- minus sign, U+2212 ISOtech -->
<!ENTITY lowast   "&#8727;" ><!-- asterisk operator, U+2217 ISOtech -->
<!ENTITY radic    "&#8730;" ><!-- square root = radical sign,
                               U+221A ISOtech -->
<!ENTITY prop     "&#8733;" ><!-- proportional to, U+221D ISOtech -->
<!ENTITY infin    "&#8734;" ><!-- infinity, U+221E ISOtech -->
<!ENTITY ang      "&#8736;" ><!-- angle, U+2220 ISOamso -->
<!ENTITY and      "&#8743;" ><!-- logical and = wedge, U+2227 ISOtech -->
<!ENTITY or       "&#8744;" ><!-- logical or = vee, U+2228 ISOtech -->
<!ENTITY cap      "&#8745;" ><!-- intersection = cap, U+2229 ISOtech -->
<!ENTITY cup      "&#8746;" ><!-- union = cup, U+222A ISOtech -->
<!ENTITY int      "&#8747;" ><!-- integral, U+222B ISOtech -->
<!ENTITY there4   "&#8756;" ><!-- therefore, U+2234 ISOtech -->
<!ENTITY sim      "&#8764;" ><!-- tilde operator = varies with = similar to,
                               U+223C ISOtech -->
<!-- tilde operator is NOT the same character as the tilde, U+007E,
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     although the same glyph might be used to represent both  -->
<!ENTITY cong     "&#8773;" ><!-- approximately equal to, U+2245 ISOtech -->
<!ENTITY asymp    "&#8776;" ><!-- almost equal to = asymptotic to,
                                U+2248 ISOamsr -->
<!ENTITY ne       "&#8800;" ><!-- not equal to, U+2260 ISOtech -->
<!ENTITY equiv    "&#8801;" ><!-- identical to, U+2261 ISOtech -->
<!ENTITY le       "&#8804;" ><!-- less-than or equal to, U+2264 ISOtech -->
<!ENTITY ge       "&#8805;" ><!-- greater-than or equal to,
                                U+2265 ISOtech -->
<!ENTITY sub      "&#8834;" ><!-- subset of, U+2282 ISOtech -->
<!ENTITY sup      "&#8835;" ><!-- superset of, U+2283 ISOtech -->
<!-- note that nsup, 'not a superset of, U+2283' is not covered by the Symbol
     font encoding and is not included. Should it be, for symmetry?
     It is in ISOamsn  -->
<!ENTITY nsub     "&#8836;" ><!-- not a subset of, U+2284 ISOamsn -->
<!ENTITY sube     "&#8838;" ><!-- subset of or equal to, U+2286 ISOtech -->
<!ENTITY supe     "&#8839;" ><!-- superset of or equal to,
                                U+2287 ISOtech -->
<!ENTITY oplus    "&#8853;" ><!-- circled plus = direct sum,
                                U+2295 ISOamsb -->
<!ENTITY otimes   "&#8855;" ><!-- circled times = vector product,
                                U+2297 ISOamsb -->
<!ENTITY perp     "&#8869;" ><!-- up tack = orthogonal to = perpendicular,
                                U+22A5 ISOtech -->
<!ENTITY sdot     "&#8901;" ><!-- dot operator, U+22C5 ISOamsb -->
<!-- dot operator is NOT the same character as U+00B7 middle dot -->

<!-- Miscellaneous Technical -->
<!ENTITY lceil    "&#8968;" ><!-- left ceiling = apl upstile,
                                U+2308 ISOamsc  -->
<!ENTITY rceil    "&#8969;" ><!-- right ceiling, U+2309 ISOamsc  -->
<!ENTITY lfloor   "&#8970;" ><!-- left floor = apl downstile,
                                U+230A ISOamsc  -->
<!ENTITY rfloor   "&#8971;" ><!-- right floor, U+230B ISOamsc  -->
<!ENTITY lang     "&#9001;" ><!-- left-pointing angle bracket = bra,
                                U+2329 ISOtech -->
<!-- lang is NOT the same character as U+003C 'less than'
     or U+2039 'single left-pointing angle quotation mark' -->
<!ENTITY rang     "&#9002;" ><!-- right-pointing angle bracket = ket,
                                U+232A ISOtech -->
<!-- rang is NOT the same character as U+003E 'greater than'
     or U+203A 'single right-pointing angle quotation mark' -->

<!-- Geometric Shapes -->
<!ENTITY loz      "&#9674;" ><!-- lozenge, U+25CA ISOpub -->

<!-- Miscellaneous Symbols -->
<!ENTITY spades   "&#9824;" ><!-- black spade suit, U+2660 ISOpub -->
<!-- black here seems to mean filled as opposed to hollow -->
<!ENTITY clubs    "&#9827;" ><!-- black club suit = shamrock,
                                U+2663 ISOpub -->
<!ENTITY hearts   "&#9829;" ><!-- black heart suit = valentine,
                                U+2665 ISOpub -->
<!ENTITY diams    "&#9830;" ><!-- black diamond suit, U+2666 ISOpub -->
```