

# Access Data Forensic Toolkit (FTK) Version 7.0.0.163

Test Results for String Search Tool



**Homeland  
Security**

Science and Technology

This report was prepared for the Department of Homeland Security (DHS) Science and Technology Directorate (S&T) by the Office of Law Enforcement Standards of the National Institute of Standards and Technology.

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March 2020

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Access Data FTK Version 7.0.0.163**

## Introduction

The Computer Forensics Tool Testing (CFTT) program is a joint project of the Department of Homeland Security (DHS) Science and Technology Directorate (S&T), the National Institute of Justice, and the National Institute of Standards and Technology Special Programs Office and Information Technology Laboratory. CFTT is supported by other organizations, including the Federal Bureau of Investigation, the U.S. Department of Defense Cyber Crime Center, U.S. Internal Revenue Service Criminal Investigation Division Electronic Crimes Program, and the DHS Bureau of Immigration and Customs Enforcement, U.S. Customs and Border Protection and U.S. Secret Service. The objective of the CFTT program is to provide measurable assurance to practitioners, researchers, and other applicable users that the tools used in computer forensics investigations provide accurate results. Accomplishing this requires the development of specifications and test methods for computer forensics tools and subsequent testing of specific tools against those specifications.

Test results provide the information necessary for developers to improve tools, users to make informed choices, and the legal community and others to understand the tools' capabilities. The CFTT approach to testing computer forensics tools is based on well-recognized methodologies for conformance and quality testing. The CFTT approach tests features that forensic labs are likely to use on a regular basis. Interested parties in the computer forensics community can review and comment on the specifications and test methods posted on the CFTT website (<https://www.cftt.nist.gov>).

This document reports the results from testing the string search function of Access Data FTK Version 7.0.0.163 (<https://www.accessdata.com/>) using the CFTT Federated Testing Test Suite Version 4.0 (beta version, final to be released in 2019) using String Searching data set Version 1.1.

Federated Testing is an expansion of the CFTT program to provide forensic investigators and labs with test materials for tool testing and to support shared test reports. The goal of Federated Testing is to help forensic investigators to test the tools that they use in their labs and to enable sharing of tool test results. CFTT's Federated Testing Forensic Tool Testing Environment and included test suites can be downloaded by visiting the [CFTT website](#) and selecting Federated Testing. The results can be optionally shared with CFTT, reviewed by CFTT staff, and then shared with the community.

Test results from this and other tools can be found on DHS's [computer forensics webpage](#).

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# How to Read This Report

This report is organized into the following sections:

1. **Tested Tool Description:** The tool name, version, and vendor information are listed.
2. **Results Summary:** This section identifies any significant anomalies observed in the test runs and provides a narrative of key findings identifying where the tool meets expectations, along with a summary of any ways the tool did not meet expectations. This section also provides any observations of interest about the tool or about testing the tool, including any observed limitations or organization-imposed restrictions on tool use.
3. **Test Environment & Selected Test Cases:** Description of hardware, software, and support environment (e.g., version of Federated Testing used, device firmware version, etc.) used in tool testing and a list identifying the applicable test cases selected from the Federated Testing String Search Test Suite.
4. **Test Result Details by Case:** Automatically generated test results that identify anomalies.

# Test Results for String Search Tool: Access Data FTK Version 7.0.0.163

## 1 Tested Tool Description

Tool Name: Access Data FTK

Tool Version: 7.0.0.163

Vendor:

Access Data  
588 West 400 South Suite 350  
Lindon, UT 84042  
Main: 801.377.5410

## 2 Results Summary

*The test data sets and test cases used to create this test report are limited to frequently encountered aspects of searching for text. Trying to cover every feature is not practical, but these test cases do cover a broad range of features. The features that are addressed in the full test data set (including features that FTK does not support) are listed below:*

- File System: MS Windows (FAT, exFAT, NTFS) and UNIX-like (Ext4, OSXJ -- Mac OS Extended (Journaled), OSXC -- Mac OS Extended (Case-sensitive, Journaled) and APFS (Apple File System).
- String Location: Active File, Deleted (but recoverable) file, Unallocated Space, and Meta-Data.
- Search Method (aka search engine): Indexed or Live.
- String Encoding: ASCII, UTF-8, UTF-16BE and UTF-16LE with and without a **byte order mark**.
- Normalized Unicode: Match alternative forms of character representation, e.g., the substring “fi” of the string “infinity” could be represented by a single ligature character or two separate characters, a letter with a diacritic mark could be represented by either one or two characters. A search for any one representation should match either representation. See Section 3.2.1.
- Language: In addition to English, strings that are representative of diacritical marks (German, French, Spanish), non-Latin characters (Russian), right-to-left presentation (Arabic), and Asian languages (Chinese, Japanese and Korean) are search targets.
- Fragmented File: String that spans two disjoint file fragments.
- Logical Operations: Combine search results with logical operators **and**, **or**, and **not**.



- Stemming: Match inflected forms derived from a word stem, e.g., a search for *run* should also match *runs*, *running*, and *ran*.
- Embedded Formatting: String with embedded formatting. MS Word and HTML.

*The following features are not supported by FTK:*

- *Normalized Unicode string searching.*
- *Stemming search is only supported for indexed search.*
- *Apple File System and ExFAT file system are not supported, but they are treated as unallocated space.*

*Two search engines were tested: Live Search and Indexed Search.*

## 2.1 General Observations

*Determining if Unicode UTF-16 text is UTF-16-BE or UTF-16-LE is problematic for some text samples, especially for Latin based characters, because a one-byte shift in starting point for a string can align with either representation. For example, consider the hex representing the string “Schönheit” in UTF-16:*

```
00 53 00 63 00 68 00 f6 00 6e 00 68 00 65 00 69 00 74 00
   s   c   h   o :   n   h   e   i   t
```

If you start the match with 00 53 00 63 00 . . . then it is UTF-16-BE, but  
 If you start the match with 53 00 63 00 . . . then it is UTF-16-LE, so without any other information it could be either BE or LE. This is an artifact of UTF-16 characters that have a first byte of zero for the big-endian representation (as in Latin based characters).

## 2.2 Live Search Anomalies and Observations

*The following behaviors were observed when using the live search engine:*

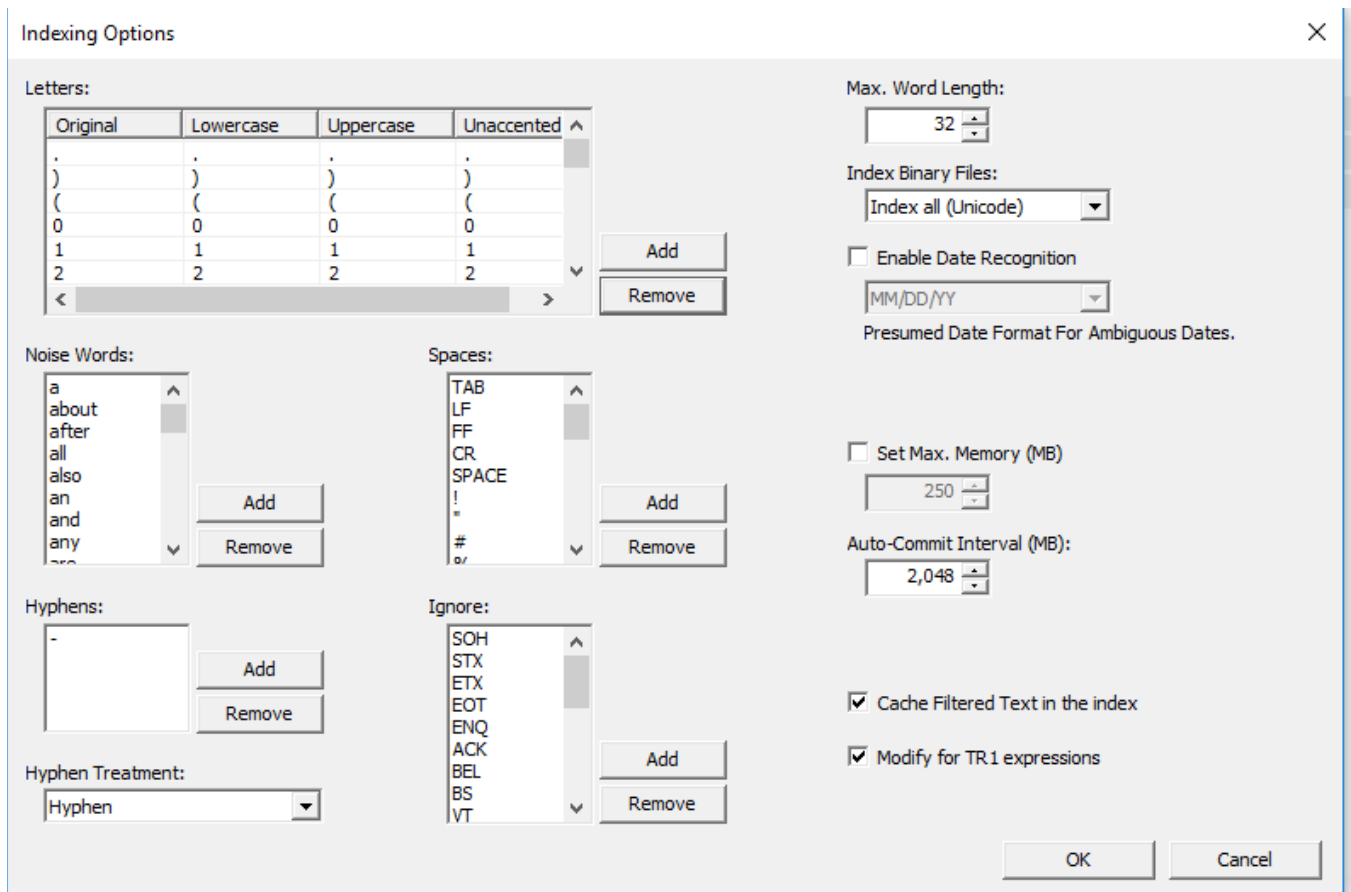
- *The ExFAT file system is not recognized and is treated as unallocated storage.*
- *The APFS file system is not recognized and is treated as unallocated storage.*
- *The tool live search filters out (does not report) social security number string hits that begin with the digit 9. The Social Security Administration does not issue numbers that begin with a 9, so this may be a tool feature to weed out strings that can't be a valid social security number. However, the IRS does issue **Individual Taxpayer Identification Numbers (ITIN)** in the same format as social security numbers for use by tax payers that do not have a social security number. All ITINs begin with a 9.*
- *No normalization of search strings is performed. Some Unicode strings may be in one of several possible normalized forms. Each form must be explicitly searched for. See Section 3.2.1.*
- *Target strings in HTML files with embedded HTML tags are not reported.*
- *Target strings in MS Word DOCX files are not reported.*



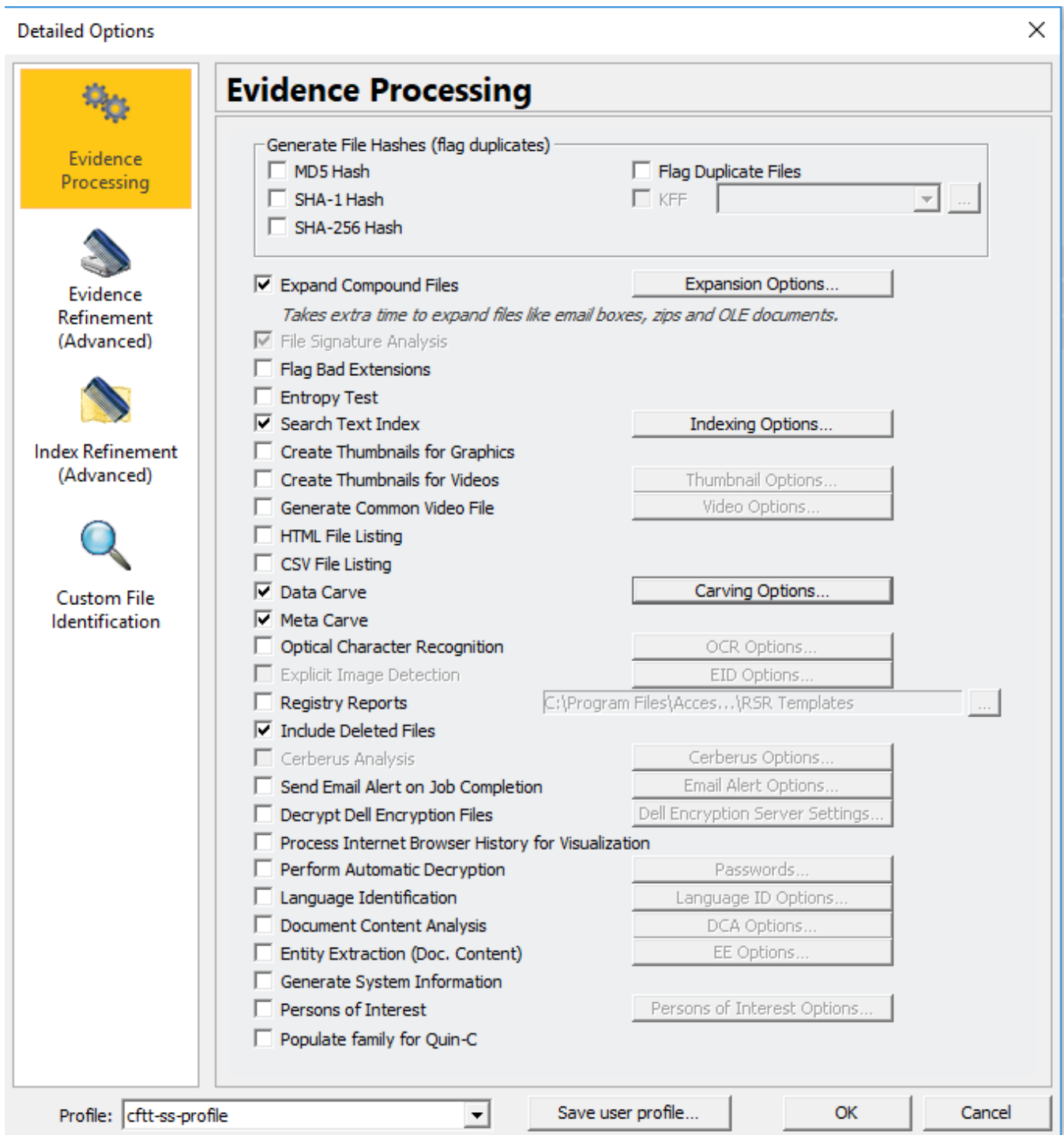
## 2.3 Indexed Search Anomalies and Observations

*Indexed search is a two-step process. First, an index of words must be built before any searches are run. Second, search targets are looked-up in the index.*

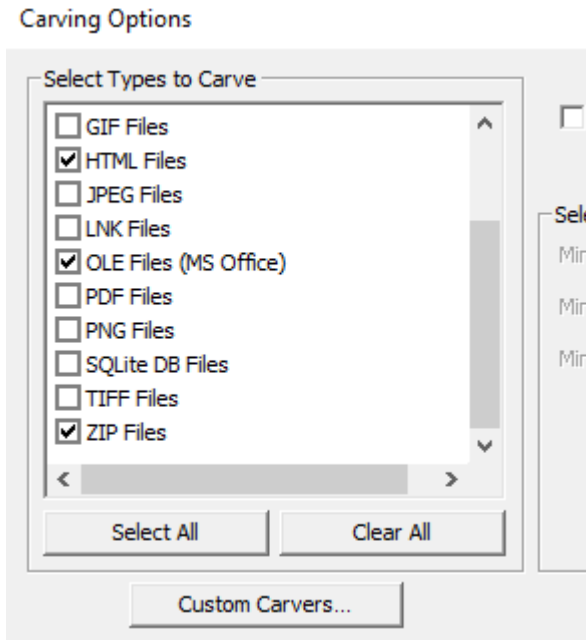
*Configuring the tool to build an index of words must be done with attention to what characters are considered valid for a word. This matters for items like social security numbers and phone numbers. The default treatment for period, hyphen, and parentheses is as spaces, i.e., word breaks. However, when indexing for social security numbers (with hyphens) or phone numbers (with other special characters), the special characters must be considered valid word characters and not word breaks. The following figure shows the indexing configuration:*



*In addition, configuration for indexing files that must be unzipped or carved (or both) requires ensuring that the following settings are selected from the **Detailed Options**:*



The following **Carving Options** should also be selected:



*The following behaviors were observed when using the indexed search engine:*

- *The ExFAT file system is not recognized and is treated as unallocated storage.*
- *The APFS file system is not recognized and is treated as unallocated storage.*
- No meta-data search strings are reported.
- *No normalization of search strings is performed. Some Unicode strings may be in one of several possible normalized forms. Each form must be explicitly searched for. See Section 3.2.1.*
- Multi-character Asian search strings report multiple hits, one hit for each character in the string, e.g., 中国 reports two hits, スバル reports three hits and みつびし reports four hits.
- UTF-16 strings are missed in unallocated storage for certain identified languages. The languages identified are: Chinese, Korean, Japanese Kanji, Japanese Kana, and English with ligatures.
- UTF-16-BE strings are missed in unallocated storage for certain identified languages. The languages identified are: Russian, Arabic, and NFD normalized Latin based languages (German, Italian, and Spanish).
- For deleted files in OSXJ and OSXC Unix data-set partitions, no UTF strings are returned for Chinese, Korean, Japanese Kanji, and Japanese Kana.
- Initially no hits were reported for pre-defined search for U.S. Phone numbers. The tool uses a pre-defined regular expression to match numbers conforming to the NANP (North American Phone Numbering Plan)<sup>1</sup>. The phone number format is as follows:
  - Optional “1” followed by a hyphen or period.
  - Optional 3-digit *area code* enclosed in parentheses or followed by a hyphen or period.

<sup>1</sup> See [https://en.wikipedia.org/wiki/North\\_American\\_Numbering\\_Plan](https://en.wikipedia.org/wiki/North_American_Numbering_Plan) for details.

- 3-digit *central office exchange code* followed by a hyphen or period, and 4-digit line number.

The pre-defined regular expression incorrectly specifies the match for the punctuation that follows the three digits of the area code. The supplied regular expression is “d{3}[\-\.])?” The intent is a 3-digit number followed by either a hyphen, period, or a right parenthesis. The regular expression is missing a right bracket to close the list of three characters to match following the 3-digit number: “d{3}[\-\.])?” After adjusting the regular expression and retrying the search, all expected US phone numbers were found.

## 3 Test Environment & Selected Test Cases

This section describes test hardware, software, test data sets, and test cases.

### 3.1 Test Hardware and Software

FTK Version 7.0.0.163 was installed on a Dell OptiPlex 7050 with 32GB installed RAM, running Microsoft Windows 10 Enterprise, Version 1607, OS Build 14393.2068.

Testing was performed using CFTT Federated Testing Test Suite Version 4.0 (beta version, final to be released in 2019).

### 3.2 Test Data Sets and Test Cases

#### 3.2.1 Test Data Sets

String search test data set package Version 1.1 was used. The package can be downloaded from either the CFTT website ([www.cftt.nist.gov](http://www.cftt.nist.gov) then select String Searching) or the CFReDS website ([www.cfreds.nist.gov](http://www.cfreds.nist.gov)). The package includes two dd files with known content. One of the dd test images contains target strings within FAT, ExFAT and NTFS file systems (Windows), the other dd test image contains target strings from HFS+ journaled, case insensitive (OSXJ), HFS+ journaled, case sensitive (OSXC), ext4 file system, and APFS (Apple file system) (UNIX-like).

In general, each target string is encoded in ASCII and located in both an active file and a recoverable deleted file in each partition of the test image. The Windows dd image also has a block of unallocated storage that contains the target strings without a file system. Some of the target strings are also encoded in Unicode UTF-8, UTF-16BE, and UTF-16LE with a byte-order-mark. Test case FT-SS-07 is organized to test language and Unicode specific situations such as Unicode UTF-16 without a byte-order-mark, Unicode text with and without combining characters (diacritic marks), and Unicode text with and without ligatures (“fi” as two characters and as one character). Test case FT-SS-09 is organized to test specific situations such as formatted strings, strings spanning file fragments, and strings located in

inaccessible areas. Each instance of a target string also has a unique associated string ID located immediately after the target string. The string ID helps identify the specific string matched by the search tool.

### 3.3 Test Case Descriptions

The following table gives a brief description of available test cases in the data sets. Not all test cases are used for all data sets.

Case	Case Description
FT-SS-01	Search ASCII
FT-SS-02	Search Ignore Case
FT-SS-03	Search for Words
FT-SS-04	Search Logical AND
FT-SS-05	Search Logical OR
FT-SS-06	Search Logical NOT
FT-SS-07-CJK-char	Search Unicode Chinese/Japanese ideograms (Asian)
FT-SS-07-CJK-hangul	Search Unicode CJK Korean Hangul (Asian)
FT-SS-07-CJK-kana	Search Unicode CJK Japanese phonetic Kana (Asian)
FT-SS-07-Cyrillic	Search Unicode Cyrillic (Russian)
FT-SS-07-Latin	Search Unicode Latin (French & German)
FT-SS-07-NoBOM	Search Unicode 16 without a byte-order-mark
FT-SS-07-Norm	Normalized Search of Unicode text with diacritic marks (NFC & NFD) and ligatures (NFKC & NFKD)
FT-SS-07-RTL	Search Unicode RTL (Arabic)
FT-SS-08-Email	Search Tool-defined Queries -- Email Address
FT-SS-08-Phone	Search Tool-defined Queries -- Telephone Number
FT-SS-08-SS	Search Tool-defined Queries -- Social Security
FT-SS-09-Doc	Search Formatted Document Text
FT-SS-09-Frag*	Search Fragmented File
FT-SS-09-Lost*	Search Inaccessible (lost) Areas
FT-SS-09-MFT*	Search File in NTFS Master File Table (MFT)
FT-SS-09-Meta	Search file name substring in Meta-data
FT-SS-09-Stem	Search for matches to word stem
FT-SS-10-Hex	Search Hexadecimal Character Match
FT-SS-10-Regex	Search Pattern Character Match

Some test cases are for specific features, e.g., logical conditions (**and**, **or**, **not**), built in searches (email, telephone numbers), etc. Three test cases (marked with "\*"), FT-SS-09-Frag, FT-SS-09-Lost & FT-SS-09-MFT, are only applied to the Windows data set.

## 4 Test Result Details by Case (per Data Set)

A string search tool may implement more than one search algorithm (also known as a search engine) for searching text. The two most common search engines are *indexed search* and *live search*. An indexed search reads all the acquired data once before doing any searching and builds an index to all words found. Each query can be looked up quickly in the index. A Live search reads all the acquired data for each query.

This section presents test results by test image (windows file systems, or UNIX-like file systems). For each test image, there is a result table for each search engine tested. Each table shows results by test case of the number of expected search hits, the number of actual search hits, and the number of strings missed (i.e., expected hits minus actual hits) for allocated files, deleted files, and unallocated space.

The following search engines were tested: Indexed and Live. The indexed search engine testing skips the following cases:

- FT-SS-02
- FT-SS-06
- FT-SS-08-email
- FT-SS-10-HEX
- FT-SS-10-REGEX

The live search engine testing skips the following test cases:

- FT-SS-03
- FT-SS-04
- FT-SS-06
- FT-SS-09-STEM

### 4.1 Results for Data Set: Windows

This section provides results for the Windows data set.

#### 4.1.1 Results for Indexed Search of Windows Data Set

The table columns contain the following information:

- **Case:** The test case identifier.
- **Expected String:** The strings that should be reported by the search.

- **Active Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in an active file.
- **Deleted Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in a deleted file.
- **Unallocated Space:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in unallocated space.
- **Expected:** The number of instances of the expected string found in the group (i.e., Active files, Deleted files, or Unallocated space).
- **Hits:** The number of times the expected string was found in the group.
- **Misses:** The number of times the expected string was missed (not found) in the group.

*Notes: The first row of results for a test case is a summary for all the strings that should be found for that case.*

In the Expected String column for test case FT-SS-09-DOC, each string is labeled to indicate features of the expected string. The labels include the file type (.doc, .docx, or .html) and the encoding of the string (if a .doc file). If the string has embedded formatting it is labeled as *Formatted*, e.g., the string *crossbow* has the substring *cross* formatted as bold and underlined, i.e., **crossbow**.

Results for Indexed Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-01		3	3	0	3	3	0	1	1	0
	DireWolf	3	3	0	3	3	0	1	1	0
FT-SS-03		9	9	0	9	9	0	3	3	0
	WOLF	3	3	0	3	3	0	1	1	0
	wolf	3	3	0	3	3	0	1	1	0
	Wolf	3	3	0	3	3	0	1	1	0
FT-SS-04		3	3	0	3	3	0	0	0	0
	panda and fox	3	3	0	3	3	0	0	0	0
FT-SS-05		6	6	0	6	6	0	2	2	0
	DireWolf	3	3	0	3	3	0	1	1	0
	WereWolf	3	3	0	3	3	0	1	1	0



Results for Indexed Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-07-CJK-char		18	16	2	18	16	2	6	4	2
	中国	9	7	2	9	7	2	3	1	2
	東京	9	9	0	9	9	0	3	3	0
FT-SS-07-CJK-hangul		9	7	2	9	7	2	3	1	2
	□ □	9	7	2	9	7	2	3	1	2
FT-SS-07-CJK-kana		18	14	4	18	14	4	6	2	4
	スバル	9	7	2	9	7	2	3	1	2
	みつびし	9	7	2	9	7	2	3	1	2
FT-SS-07-Cyrillic		9	8	1	9	8	1	3	2	1
	Сибирь	9	8	1	9	8	1	3	2	1
FT-SS-07-Latin		18	18	0	18	18	0	6	6	0
	garçon	9	9	0	9	9	0	3	3	0
	Schönheit	9	9	0	9	9	0	3	3	0
FT-SS-07-NoBOM		39	35	4	39	35	4	13	9	4
	Россия	9	8	1	9	8	1	3	2	1
	فلافل	9	8	1	9	8	1	3	2	1
	中國	9	7	2	9	7	2	3	1	2
	QuarterHorse	12	12	0	12	12	0	4	4	0
FT-SS-07-Norm		75	70	5	75	70	5	25	20	5
	mañana (NFD)	9	8	1	9	8	1	3	2	1
	infinity (No Ligature)	12	12	0	12	12	0	4	4	0
	Mäuse (NFD)	9	8	1	9	8	1	3	2	1
	infinity (Ligature)	9	7	2	9	7	2	3	1	2
	Mäuse (NFC)	9	9	0	9	9	0	3	3	0
	libertà (NFC)	9	9	0	9	9	0	3	3	0
	libertà (NFD)	9	8	1	9	8	1	3	2	1
	mañana (NFC)	9	9	0	9	9	0	3	3	0
	FT-SS-07-RTL		9	8	1	9	8	1	3	2
الكسكس		9	8	1	9	8	1	3	2	1
FT-SS-08-Phone		21	21	0	21	21	0	7	7	0
	800-555-1122	3	3	0	3	3	0	4	4	0
	202.555.3270	3	3	0	3	3	0	4	4	0
	301.555-9009	12	12	0	12	12	0	4	4	0
	(901)555-1111	3	3	0	3	3	0	1	1	0

Results for Indexed Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-08-SS		9	9	0	9	9	0	3	3	0
	123-45-6789	3	3	0	3	3	0	1	1	0
	999-55-1321	3	3	0	3	3	0	1	1	0
	987-65-4321	3	3	0	3	3	0	1	1	0
FT-SS-09-Doc		16	16	0	0	0	0	16	16	0
	longbow .html	2	2	0	0	0	0	2	2	0
	shotgun Formatted .doc UTF-16	2	2	0	0	0	0	2	2	0
	revolver .doc UTF-16	2	2	0	0	0	0	2	2	0
	peroxide .docx	2	2	0	0	0	0	2	2	0
	nitroglycerin Formatted .docx	2	2	0	0	0	0	2	2	0
	rifle .doc UTF-8	2	2	0	0	0	0	2	2	0
	crossbow Formatted .html	2	2	0	0	0	0	2	2	0
	flintlock Formatted .doc UTF-8	2	2	0	0	0	0	2	2	0
FT-SS-09-Frag		2	2	0	0	0	0	0	0	0
	Washington	1	1	0	0	0	0	0	0	0
	California	1	1	0	0	0	0	0	0	0
FT-SS-09-Lost		0	0	0	0	0	0	4	4	0
	SecretKey	0	0	0	0	0	0	2	2	0
	disconnected	0	0	0	0	0	0	2	2	0
FT-SS-09-MFT		4	4	0	4	4	0	0	0	0
	bear	4	4	0	4	4	0	0	0	0
FT-SS-09-Meta		6	6	0	6	6	0	2	2	0
	cañón	3	3	0	3	3	0	1	1	0
	thunderbird	3	3	0	3	3	0	1	1	0

Results for Indexed Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-09-Stem		48	48	0	48	48	0	16	16	0
	city	3	3	0	3	3	0	1	1	0
	planner	3	3	0	3	3	0	1	1	0
	plans	3	3	0	3	3	0	1	1	0
	stealing	3	3	0	3	3	0	1	1	0
	steal	3	3	0	3	3	0	1	1	0
	planning	3	3	0	3	3	0	1	1	0
	knives	3	3	0	3	3	0	1	1	0
	planned	3	3	0	3	3	0	1	1	0
	plan	3	3	0	3	3	0	1	1	0
	knife	3	3	0	3	3	0	1	1	0
	cities	12	12	0	12	12	0	4	4	0
	steals	3	3	0	3	3	0	1	1	0
	stealer	3	3	0	3	3	0	1	1	0

#### 4.1.2 Meta-Data results for Indexed Search of Windows Data Set

The following table presents search results for strings located in file system meta-data. The **Case** column identifies the test case, the **String** column identifies the search string, the **Partition** column identifies the partition (file system) where the string is located, and the **Seen** column records if the search tool reported at least one instance of the string (yes or no) in meta-data.

Meta-Data Results for Indexed Search of Windows Data Set			
Case	String	Partition	Seen
FT-SS-09-Meta			
	thunderbird	ntfs	No
	cañón	fat32	No
	cañón	exfat	No
	cañón	ntfs	No

#### 4.1.3 Comments on Indexed Search of Windows Data Set

The following table presents any comments recorded during testing for a test case.

Case	Comments on Indexed Search of Windows Data Set
FT-SS-04	Some additional hits reported in unallocated space
FT-SS-07-CJK-kana	スバル hits are reported three times みつびし hits are reported four times

#### 4.1.4 Results for Live Search of Windows Data Set

The table columns contain the following information:

- **Case:** The test case identifier.
- **Expected String:** The strings that should be reported by the search.
- **Active Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in an active file.
- **Deleted Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in a deleted file.
- **Unallocated Space:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in unallocated space.
- **Expected:** The number of instances of the expected string found in the group (i.e., Active files, Deleted files, or Unallocated space).
- **Hits:** The number of times the expected string was found in the group.
- **Misses:** The number of times the expected string was missed (not found) in the group.

*Notes: The first row of results for a test case is a summary for all the strings that should be found for that case.*

In the Expected String column for test case FT-SS-09-DOC, each string is labeled to indicate features of the expected string. The labels include the file type (.doc, .docx, or .html) and the encoding of the string (if a .doc file). If the string has embedded formatting it is labeled as *Formatted*, e.g., the string *crossbow* has the substring *cross* formatted as bold and underlined, i.e., **crossbow**.

Results for Live Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-01		3	3	0	3	3	0	1	1	0
	DireWolf	3	3	0	3	3	0	1	1	0
FT-SS-02		15	15	0	15	15	0	5	5	0
	WOLF	3	3	0	3	3	0	1	1	0
	wolf	3	3	0	3	3	0	1	1	0
	Wolf	3	3	0	3	3	0	1	1	0
	DireWolf	3	3	0	3	3	0	1	1	0
	WereWolf	3	3	0	3	3	0	1	1	0
FT-SS-05		6	6	0	6	6	0	2	2	0
	DireWolf	3	3	0	3	3	0	1	1	0
	WereWolf	3	3	0	3	3	0	1	1	0
FT-SS-07-CJK-char		18	18	0	18	18	0	6	6	0
	中国	9	9	0	9	9	0	3	3	0
	東京	9	9	0	9	9	0	3	3	0
FT-SS-07-CJK-hangul		9	9	0	9	9	0	3	3	0
	□ □	9	9	0	9	9	0	3	3	0
FT-SS-07-CJK-kana		18	18	0	18	18	0	6	6	0
	スバル	9	9	0	9	9	0	3	3	0
	みつびし	9	9	0	9	9	0	3	3	0
FT-SS-07-Cyrillic		9	9	0	9	9	0	3	3	0
	Сибирь	9	9	0	9	9	0	3	3	0
FT-SS-07-Latin		18	18	0	18	18	0	6	6	0
	garçon	9	9	0	9	9	0	3	3	0
	Schönheit	9	9	0	9	9	0	3	3	0
FT-SS-07-NoBOM		39	39	0	39	39	0	13	13	0
	Россия	9	9	0	9	9	0	3	3	0
	فلافل	9	9	0	9	9	0	3	3	0
	中國	9	9	0	9	9	0	3	3	0
	QuarterHorse	12	12	0	12	12	0	4	4	0

Results for Live Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-07-RTL		9	9	0	9	9	0	3	3	0
	الكسكس	9	9	0	9	9	0	3	3	0
FT-SS-08-Email		21	21	0	21	21	0	7	7	0
	iron.man@marvel.com	12	12	0	12	12	0	4	4	0
	potus@capitol.gov	3	3	0	3	3	0	1	1	0
	berlin@deutschland.net	3	3	0	3	3	0	1	1	0
	kgb@moscow.redsquare.ru	3	3	0	3	3	0	1	1	0
FT-SS-08-Phone		21	21	0	21	21	0	7	7	0
	301.555-9009	12	12	0	12	12	0	4	4	0
	800-555-1122	3	3	0	3	3	0	1	1	0
	(901)555-1111	3	3	0	3	3	0	1	1	0
	202.555.3270	3	3	0	3	3	0	1	1	0
FT-SS-08-SS		9	3	6	9	3	6	3	1	2
	987-65-4321	3	0	3	3	0	3	1	0	1
	999-55-1321	3	0	3	3	0	3	1	0	1
	123-45-6789	3	3	0	3	3	0	1	1	0

Results for Live Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-09-Doc		16	13	3	0	0	0	16	13	3
	longbow.html	2	2	0	0	0	0	2	2	0
	shotgun Formatted.doc UTF-16	2	2	0	0	0	0	2	2	0
	revolver.doc UTF-16	2	2	0	0	0	0	2	2	0
	peroxide.docx	2	1	1	0	0	0	2	1	1
	nitroglycerin Formatted.docx	2	1	1	0	0	0	2	1	1
	rifle.doc UTF-8	2	2	0	0	0	0	2	2	0
	crossbow Formatted.html	2	1	1	0	0	0	2	1	1
	flintlock Formatted.doc UTF-8	2	2	0	0	0	0	2	2	0
FT-SS-09-Frag		2	2	0	0	0	0	0	0	0
	Washington	1	1	0	0	0	0	0	0	0
	California	1	1	0	0	0	0	0	0	0
FT-SS-09-Lost		0	0	0	0	0	0	4	4	0
	SecretKey	0	0	0	0	0	0	2	2	0
	disconnected	0	0	0	0	0	0	2	2	0



Results for Live Search of Windows Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-09-MFT		4	4	0	4	4	0	0	0	0
	bear	4	4	0	4	4	0	0	0	0
FT-SS-09-Meta		6	6	0	6	6	0	2	2	0
	cañón	3	3	0	3	3	0	1	1	0
	thunderbird	3	3	0	3	3	0	1	1	0
FT-SS-10-Hex		3	3	0	3	3	0	1	1	0
	panda	3	3	0	3	3	0	1	1	0
FT-SS-10-Regex		6	6	0	6	6	0	2	2	0
	DireWolf	3	3	0	3	3	0	1	1	0
	WereWolf	3	3	0	3	3	0	1	1	0

#### 4.1.5 Meta-Data Results for Live Search of Windows Data Set

The following table presents search results for strings located in the file system meta-data. The **Case** column identifies the test case, the **String** column identifies the search string, the **Partition** column identifies the partition (file system) where the string is located, and the **Seen** column records if the search tool reported at least one instance of the string (yes or no) in meta-data.

Meta-Data Results for Live Search of Windows Data Set			
Case	String	Partition	Seen
FT-SS-09-Meta			
	thunderbird	ntfs	Yes
	cañón	fat32	Yes
	cañón	exfat	Yes
	cañón	ntfs	Yes

#### 4.1.6 Comments on Live Search of Windows Data Set

The following table presents any comments recorded during testing for a test case.

Case	Comments on Live Search of Windows Data Set
FT-SS-07-Latin	UTF-16 hits are reported both as BE & LE

FT-SS-08-SS	Tool filters out invalid social security numbers
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## 4.2 Results for Data Set: UNIX

This section provides results for the UNIX data set.

### 4.2.1 Results for Indexed Search of UNIX Data Set

The table columns contain the following information:

- **Case:** The test case identifier.
- **Expected String:** The strings that should be reported by the search.
- **Active Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in an active file.
- **Deleted Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in a deleted file.
- **Unallocated Space:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in unallocated space.
- **Expected:** The number of instances of the expected string found in the group (i.e., Active files, Deleted files, or Unallocated space).
- **Hits:** The number of times the expected string was found in the group.
- **Misses:** The number of times the expected string was missed (not found) in the group.

*Notes: The first row of results for a test case is a summary for all the strings that should be found for that case.*

In the Expected String column for test case FT-SS-09-DOC, each string is labeled to indicate features of the expected string. The labels include the file type (.doc, .docx, or .html) and the encoding of the string (if a .doc file). If the string has embedded formatting it is labeled as *Formatted*, e.g., the string *crossbow* has the substring *cross* formatted as bold and underlined, i.e., **cross**bow.

Results for Indexed Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-01		4	4	0	4	4	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
FT-SS-03		12	12	0	12	12	0	0	0	0
	WOLF	4	4	0	4	4	0	0	0	0
	wolf	4	4	0	4	4	0	0	0	0
	Wolf	4	4	0	4	4	0	0	0	0
FT-SS-04		4	4	0	4	4	0	0	0	0
	panda and fox	4	4	0	4	4	0	0	0	0
FT-SS-05		8	8	0	8	8	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
	WereWolf	4	4	0	4	4	0	0	0	0
FT-SS-07-CJK-char		24	20	4	24	3	21	0	0	0
	中国	12	10	2	12	2	10	0	0	0
	東京	12	10	2	12	1	11	0	0	0
FT-SS-07-CJK-hangul		12	10	2	12	1	11	0	0	0
	□ □	12	10	2	12	1	11	0	0	0
FT-SS-07-CJK-kana		24	20	4	24	2	22	0	0	0
	スバル	12	10	2	12	1	11	0	0	0
	みつびし	12	10	2	12	1	11	0	0	0

Results for Indexed Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-07-Cyrillic		12	11	1	12	4	8	0	0	0
	Сибирь	12	11	1	12	4	8	0	0	0
FT-SS-07-Latin		24	24	0	24	12	12	0	0	0
	garçon	12	12	0	12	6	6	0	0	0
	Schönheit	12	12	0	12	6	6	0	0	0
FT-SS-07-NoBOM		52	49	3	52	22	30	0	0	0
	Россия	12	11	1	12	4	8	0	0	0
	فلافل	12	12	0	12	4	8	0	0	0
	中國	12	10	2	12	2	10	0	0	0
	QuarterHorse	16	16	0	16	12	4	0	0	0
FT-SS-07-Norm		100	96	4	100	46	54	0	0	0
	mañana (NFD)	12	12	0	12	6	6	0	0	0
	infinity (No Ligature)	16	16	0	16	12	4	0	0	0
	Mäuse (NFD)	12	11	1	12	4	8	0	0	0
	infinity (Ligature)	12	10	2	12	2	10	0	0	0
	Mäuse (NFC)	12	12	0	12	6	6	0	0	0
	libertà (NFC)	12	12	0	12	6	6	0	0	0
	libertà (NFD)	12	11	1	12	4	8	0	0	0
	mañana (NFC)	12	12	0	12	6	6	0	0	0

Results for Indexed Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-07-RTL		12	11	1	12	4	8	0	0	0
	الكسكس	12	11	1	12	4	8	0	0	0
FT-SS-08-Phone		28	20	8	28	20	8	0	0	0
	800-555-1122	4	0	4	4	0	4	0	0	0
	202.555.3270	4	0	4	4	0	4	0	0	0
	301.555-9009	16	16	0	16	16	0	0	0	0
	(901)555-1111	4	4	0	4	4	0	0	0	0
FT-SS-08-SS		12	12	0	12	12	0	0	0	0
	123-45-6789	4	4	0	4	4	0	0	0	0
	999-55-1321	4	4	0	4	4	0	0	0	0
	987-65-4321	4	4	0	4	4	0	0	0	0
FT-SS-09-Doc		16	16	0	0	0	0	0	0	0
	longbow.html	2	2	0	0	0	0	0	0	0
	shotgun Formatted.doc UTF-16	2	2	0	0	0	0	0	0	0
	revolver.doc UTF-16	2	2	0	0	0	0	0	0	0
	peroxide.docx	2	2	0	0	0	0	0	0	0
	nitroglycerin Formatted.docx	2	2	0	0	0	0	0	0	0

Results for Indexed Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-09-Doc	rifle									
	.doc	2	2	0	0	0	0	0	0	0
	UTF-8									
	crossbow									
	Formatted.html	2	2	0	0	0	0	0	0	0
	flintlock									
	Formatted.doc	2	2	0	0	0	0	0	0	0
	UTF-8									
FT-SS-09-Meta		8	8	0	8	6	2	0	0	0
	cañón	4	4	0	4	2	2	0	0	0
	thunderbird	4	4	0	4	4	0	0	0	0
FT-SS-09-Stem		64	64	0	64	64	0	0	0	0
	city	4	4	0	4	4	0	0	0	0
	planner	4	4	0	4	4	0	0	0	0
	plans	4	4	0	4	4	0	0	0	0
	stealing	4	4	0	4	4	0	0	0	0
	steal	4	4	0	4	4	0	0	0	0
	planning	4	4	0	4	4	0	0	0	0
	knives	4	4	0	4	4	0	0	0	0
	planned	4	4	0	4	4	0	0	0	0
	plan	4	4	0	4	4	0	0	0	0
	knife	4	4	0	4	4	0	0	0	0
	cities	16	16	0	16	16	0	0	0	0
	steals	4	4	0	4	4	0	0	0	0
	stealer	4	4	0	4	4	0	0	0	0

## 4.2.2 Meta-Data Results for Indexed Search of UNIX Data Set

The following table presents search results for strings located in file system meta-data. The **Case** column identifies the test case, the **String** column identifies the search string, the **Partition** column identifies the partition (file system) where the string is located, and the **Seen** column records if the search tool reported at least one instance of the string (yes or no) in meta-data.

<b>Meta-Data Results for Indexed Search of UNIX Data Set</b>			
<b>Case</b>	<b>String</b>	<b>Partition</b>	<b>Seen</b>
FT-SS-07-CJK-char			
	中国	osxj	No
	中国	osxc	No
	中国	apfs	No
	東京	osxj	No
	東京	osxc	No
	東京	apfs	No
FT-SS-07-Cyrillic			
	Сибирь	osxj	No
	Сибирь	osxc	No
	Сибирь	apfs	No
FT-SS-07-NoBOM			
	فلافل	osxj	No
	فلافل	osxc	No
	فلافل	apfs	No
	Россия	osxj	No
	Россия	osxc	No
	Россия	apfs	No
	中國	osxj	No
	中國	osxc	No
	中國	apfs	No
FT-SS-07-RTL			
	الكسكس	osxj	No
	الكسكس	osxc	No
	الكسكس	apfs	No



FT-SS-09-Meta			
	thunderbird	osxj	No
	thunderbird	osxc	No
	thunderbird	apfs	No
	thunderbird	ext4	No
	cañón	ext4	No

### 4.2.3 Comments on Indexed Search of UNIX Data Set

The following table presents any comments recorded during testing for a test case.

Case	Comments on Indexed Search of UNIX Data Set
FT-SS-07-CJK-char	Hits reported twice
FT-SS-08-Phone	Over 1,000 false positives reported

### 4.2.4 Results for Live Search of UNIX Data Set

The table columns contain the following information:

- **Case:** The test case identifier.
- **Expected String:** The strings that should be reported by the search.
- **Active Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in an active file.
- **Deleted Files:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in a deleted file.
- **Unallocated Space:** A group of three columns (**Expected, Hits, and Misses**) giving the number of hits and misses when searching for the expected string in unallocated space.
- **Expected:** The number of instances of the expected string found in the group (i.e., Active files, Deleted files, or Unallocated space).
- **Hits:** The number of times the expected string was found in the group.
- **Misses:** The number of times the expected string was missed (not found) in the group.

*Notes: The first row of results for a test case is a summary for all the strings that should be found for that case.*

In the Expected String column for test case FT-SS-09-DOC, each string is labeled to indicate features of the expected string. The labels include the file type (.doc, .docx, or .html) and the encoding of the string (if a .doc file). If the string has embedded formatting, it is labeled as *Formatted*, e.g., the string *crossbow* has the substring *cross* formatted as bold and underlined, i.e., **crossbow**.

Results for Live Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-01		4	4	0	4	4	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
FT-SS-02		20	20	0	20	20	0	0	0	0
	WOLF	4	4	0	4	4	0	0	0	0
	wolf	4	4	0	4	4	0	0	0	0
	Wolf	4	4	0	4	4	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
	WereWolf	4	4	0	4	4	0	0	0	0
FT-SS-05		8	8	0	8	8	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
	WereWolf	4	4	0	4	4	0	0	0	0
FT-SS-07-CJK-char		24	24	0	24	24	0	0	0	0
	中国	12	12	0	12	12	0	0	0	0
	東京	12	12	0	12	12	0	0	0	0
FT-SS-07-CJK-hangul		12	12	0	12	12	0	0	0	0
	□ □	12	12	0	12	12	0	0	0	0
FT-SS-07-CJK-kana		24	24	0	24	24	0	0	0	0
	スバル	12	12	0	12	12	0	0	0	0
	みつびし	12	12	0	12	12	0	0	0	0
FT-SS-07-Cyrillic		12	12	0	12	12	0	0	0	0
	Сибирь	12	12	0	12	12	0	0	0	0
FT-SS-07-Latin		24	24	0	24	24	0	0	0	0
	garçon	12	12	0	12	12	0	0	0	0
	Schönheit	12	12	0	12	12	0	0	0	0

Results for Live Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-07-NoBOM		52	52	0	52	52	0	0	0	0
	Россия	12	12	0	12	12	0	0	0	0
	فلافل	12	12	0	12	12	0	0	0	0
	中國	12	12	0	12	12	0	0	0	0
	QuarterHorse	16	16	0	16	16	0	0	0	0
FT-SS-07-Norm		100	100	0	100	100	0	0	0	0
	mañana (NFD)	12	12	0	12	12	0	0	0	0
	infinity (No Ligature)	16	16	0	16	16	0	0	0	0
	Mäuse (NFD)	12	12	0	12	12	0	0	0	0
	infinity (Ligature)	12	12	0	12	12	0	0	0	0
	Mäuse (NFC)	12	12	0	12	12	0	0	0	0
	libertà (NFC)	12	12	0	12	12	0	0	0	0
	libertà (NFD)	12	12	0	12	12	0	0	0	0
	mañana (NFC)	12	12	0	12	12	0	0	0	0
FT-SS-07-RTL		12	12	0	12	12	0	0	0	0
	الكسكس	12	12	0	12	12	0	0	0	0
FT-SS-08-Email		28	28	0	28	28	0	0	0	0
	iron.man@marvel.com	16	16	0	16	16	0	0	0	0
	potus@capitol.gov	4	4	0	4	4	0	0	0	0
	berlin@deutchland.net	4	4	0	4	4	0	0	0	0
	kgb@moscow.red-square.ru	4	4	0	4	4	0	0	0	0

Results for Live Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-08-Phone		28	28	0	28	28	0	0	0	0
	301.555-9009	16	16	0	16	16	0	0	0	0
	800-555-1122	4	4	0	4	4	0	0	0	0
	(901)555-1111	4	4	0	4	4	0	0	0	0
	202.555.3270	4	4	0	4	4	0	0	0	0
FT-SS-08-SS		12	4	8	12	4	8	0	0	0
	987-65-4321	4	0	4	4	0	4	0	0	0
	999-55-1321	4	0	4	4	0	4	0	0	0
	123-45-6789	4	4	0	4	4	0	0	0	0
FT-SS-09-Doc		16	14	2	0	0	0	0	0	0
	longbow .html	2	2	0	0	0	0	0	0	0
	shotgun Formatted .doc UTF-16	2	2	0	0	0	0	0	0	0
	revolver .doc UTF-16	2	2	0	0	0	0	0	0	0
	peroxide .docx	2	2	0	0	0	0	0	0	0
	nitroglycerin Formatted .docx	2	1	1	0	0	0	0	0	0
	rifle .doc UTF-8	2	2	0	0	0	0	0	0	0
	crossbow Formatted .html	2	1	1	0	0	0	0	0	0
	flintlock Formatted .doc UTF-8	2	2	0	0	0	0	0	0	0

Results for Live Search of UNIX Data Set										
Case	Expected String	Active Files			Deleted Files			Unalloc Space		
		Expected	Hits	Misses	Expected	Hits	Misses	Expected	Hits	Misses
FT-SS-09-Meta		8	8	0	8	8	0	0	0	0
	cañón	4	4	0	4	4	0	0	0	0
	thunderbird	4	4	0	4	4	0	0	0	0
FT-SS-10-Hex		4	4	0	4	4	0	0	0	0
	panda	4	4	0	4	4	0	0	0	0
FT-SS-10-Regex		8	8	0	8	8	0	0	0	0
	DireWolf	4	4	0	4	4	0	0	0	0
	WereWolf	4	4	0	4	4	0	0	0	0

#### 4.2.5 Meta-Data Results for Live Search of UNIX Data Set

The following table presents search results for strings located in file system meta-data. The **Case** column identifies the test case, the **String** column identifies the search string, the **Partition** column identifies the partition (file system) where the string is located, and the **Seen** column records if the search tool reported at least one instance of the string (yes or no) in meta-data.

Meta-Data Results for Live Search of UNIX Data Set			
Case	String	Partition	Seen
FT-SS-07-CJK-char			
	中国	osxj	Yes
	中国	osxc	Yes
	中国	apfs	Yes
	東京	osxj	Yes
	東京	osxc	Yes
	東京	apfs	Yes
FT-SS-07-Cyrillic			
	Сибирь	osxj	Yes
	Сибирь	osxc	Yes
	Сибирь	apfs	Yes
FT-SS-07-NoBOM			
	فلافل	osxj	Yes

	فلافل	osxc	Yes
	فلافل	apfs	Yes
	Россия	osxj	Yes
	Россия	osxc	Yes
	Россия	apfs	Yes
	中國	osxj	Yes
	中國	osxc	Yes
	中國	apfs	Yes
FT-SS-07-RTL			
	الكسكس	osxj	Yes
	الكسكس	osxc	Yes
	الكسكس	apfs	Yes
FT-SS-09-Meta			
	thunderbird	osxj	Yes
	thunderbird	osxc	Yes
	thunderbird	apfs	Yes
	thunderbird	ext4	Yes
	cañón	ext4	Yes

#### 4.2.6 Comments on Live Search of UNIX Data Set

The following table presents any comments recorded during testing for a test case.

Case	Comments on Live Search of UNIX Data Set
FT-SS-07-Latin	UTF-16 hits are reported twice
FT-SS-08-SS	Invalid social security numbers are filtered out

END of REPORT