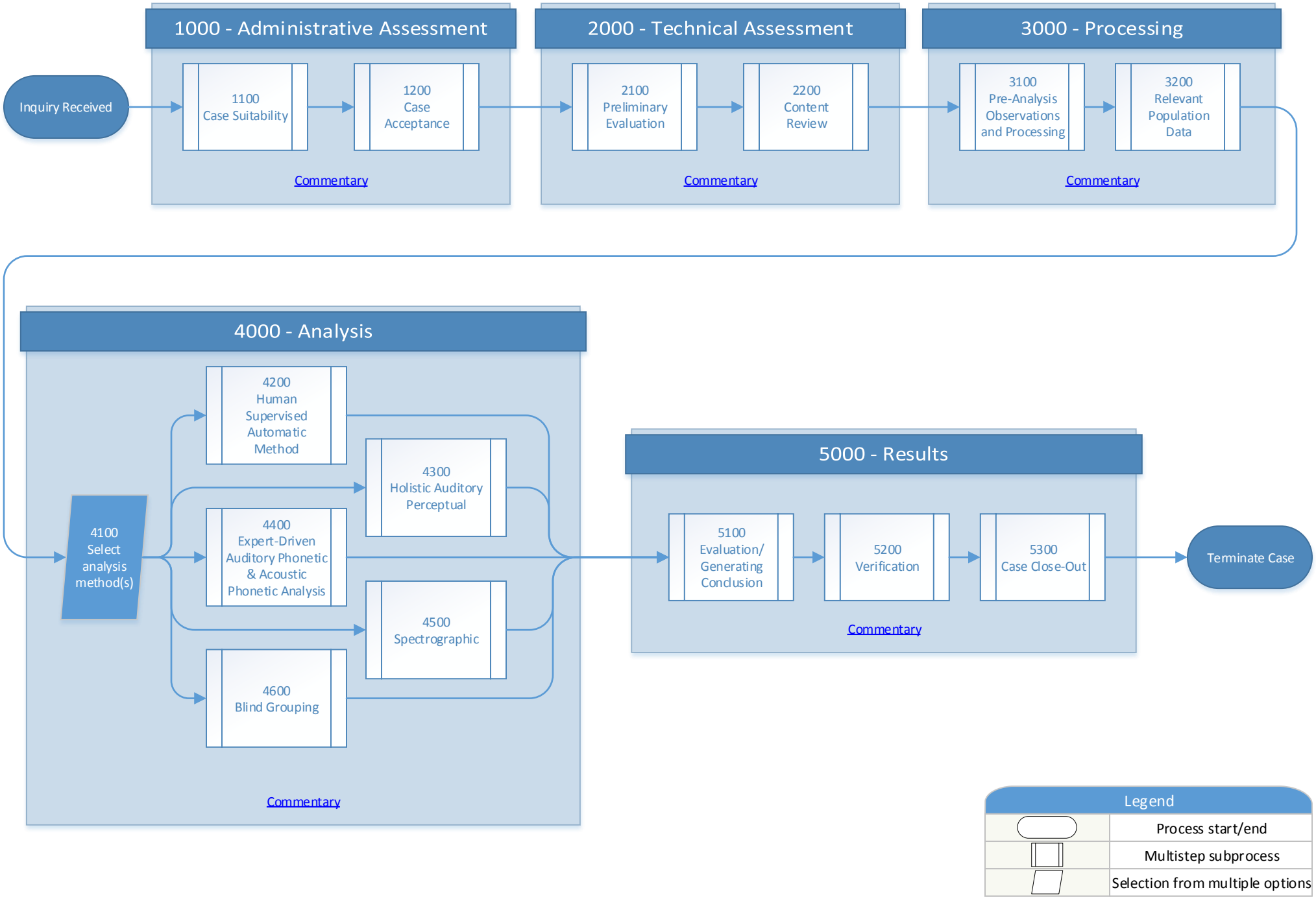
Introduction

This OSAC Speaker Recognition process map arose from the need to establish a common frame of reference to help overcome differences in terminology and participants' background and experience. The development of the process map helped the participants to better understand current practices and communicate them in a constructive way.

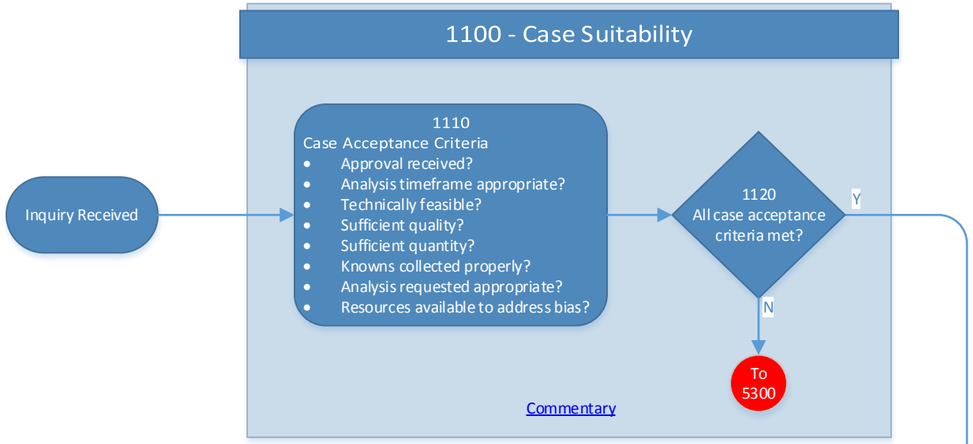
Representatives of multiple U.S. government agencies, individual practitioners, and international experts met for three days with a facilitator to create the first draft that sketched the components of a forensic examination. The current version incorporates additional contributions from a variety of researchers and practitioners. The OSAC Speaker Recognition subcommittee would like to acknowledge and thank all those who participated in the development of this process map.

The process depicted does not represent the practice of any single laboratory, but generalizes the diverse practices of multiple laboratories. This document reflects a balance between an attempt to be comprehensive and the efficient use of volunteers' time. It is intended to be descriptive only, and its release does not imply endorsement by the OSAC Speaker Recognition Subcommittee of any specific approach or process. No inferences should be drawn from the inclusion or exclusion of any approach or process or from the level of detail provided for any particular approach or process.

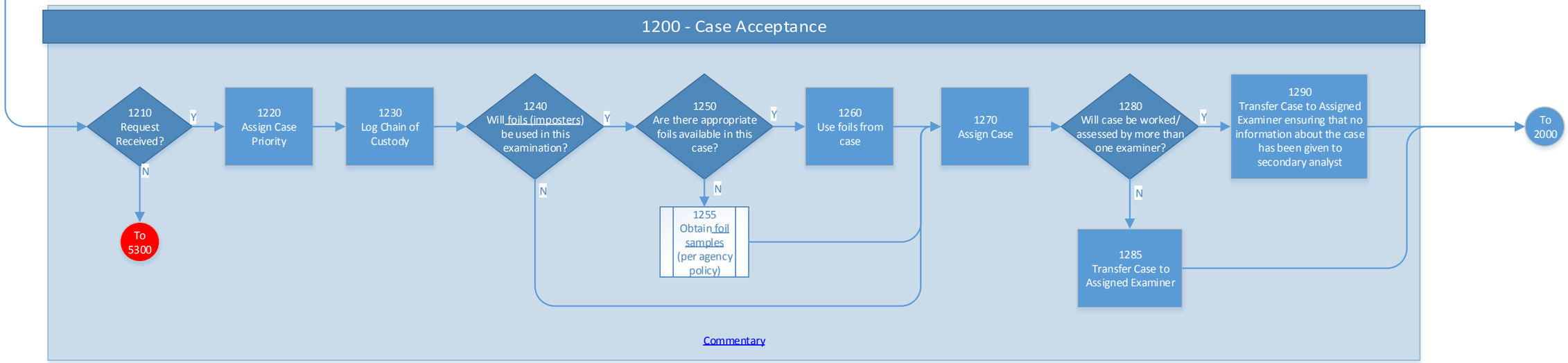
This process map is not intended to represent a best practice but rather to facilitate the development of future best practice documents by the OSAC Speaker Recognition Subcommittee.


1000 - Administrative Assessment
Inquiry Received
1100 Case Suitability
1200 Case Acceptance
Commentary
2000 - Technical Assessment
2100 Preliminary Evaluation
2200 Content Review
Commentary
3000 - Processing
3100 Pre-Analysis Observations and Processing
3200 Relevant Population Data
Commentary
4000 - Analysis
4100 Select analysis method(s)
4200 Human Supervised Automatic Method
4300 Holistic Auditory Perceptual
4400 Expert-Driven Auditory Phonetic & Acoustic Phonetic Analysis
4500 Spectrographic
4600 Blind Grouping
Commentary
5000 - Results
5100 Evaluation/ Generating Conclusion
5200 Verification
5300 Case Close-Out
Commentary
Terminate Case
Legend
Process start/end
Multistep subprocess
Selection from multiple options

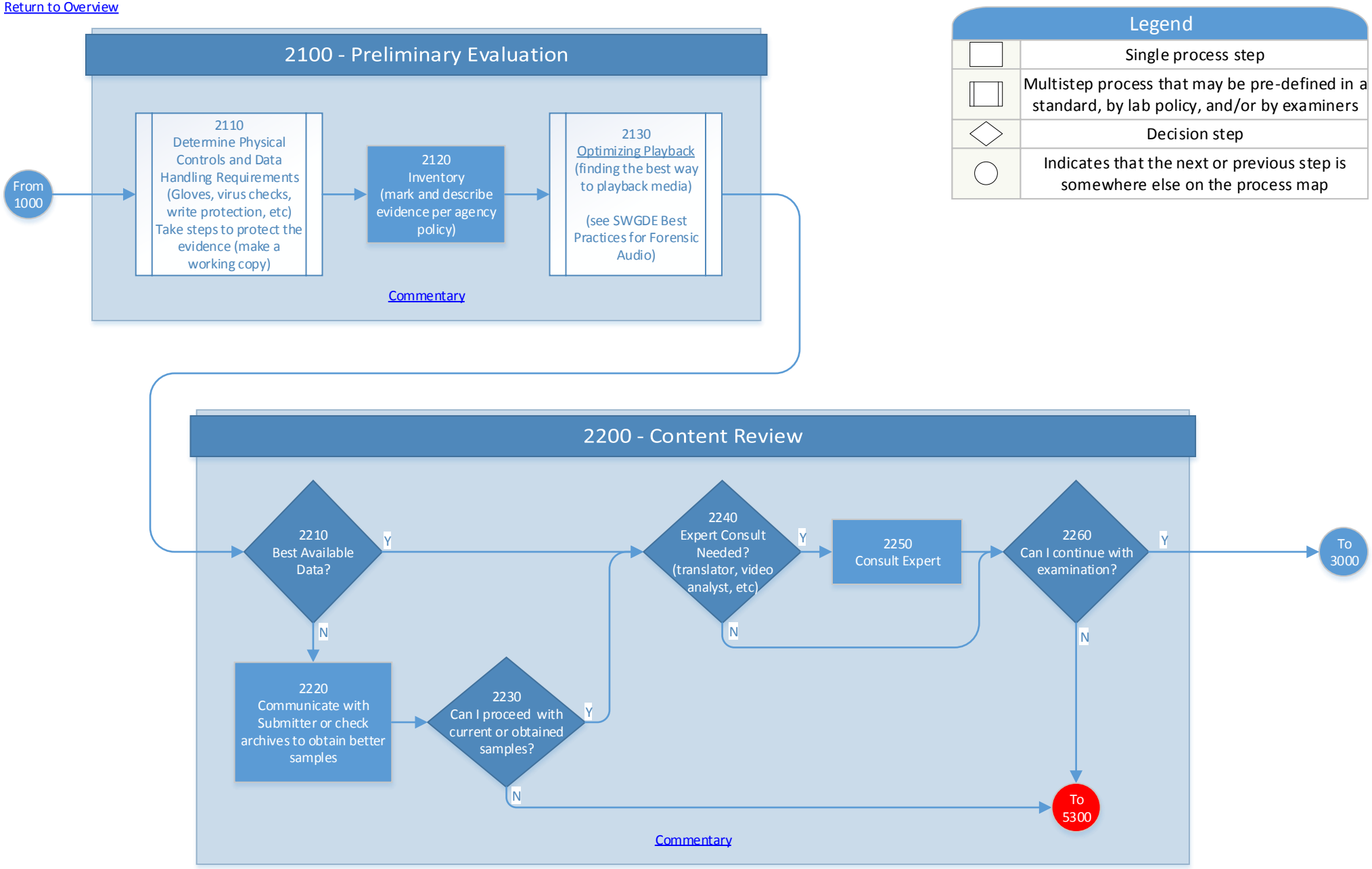
Return to Overview



Legend	
	Process start/end
	Single process step
	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
	Decision step
	Indicates that the next or previous step is somewhere else on the process map



Return to Overview



Return to Overview

3100 - Pre-Analysis Observations and Processing

From 2000

From 5100

3105 Select question of interest for analysis

3110 Observe intrinsic and extrinsic properties in Q and K (Q is the limiting evidence)

3115 Document intrinsic and extrinsic properties in Q and K

3120 Do speaking style and recording conditions match between Q and K? — Y / N

3125 Document the matching and mismatching conditions and features of the Q and K, as applicable

3130 Do I have a method that works with these data? — Y / N

3135 Will processing permit a method selection? — Y / N

3140 Process Evidence

To 5300

3145 Select appropriate method(s)

3150 Will processing improve performance of method? — Y / N

3155 Process Data (see list of processing techniques)

3160 Did processing elucidate any new intrinsic or extrinsic properties? — Y / N

3165 Document newly observed properties

Commentary

3200 – Relevant Population Data

3210 Do I have appropriate data to carry out downstream processing? — Y / N

3220 Can I obtain or simulate comparable test data? — Y / N

3230 Can I continue with examination? — Y / N

3240 Obtain or simulate required data

3250 Continue to method (consider contextual bias when deciding which method to use first)

To 4000

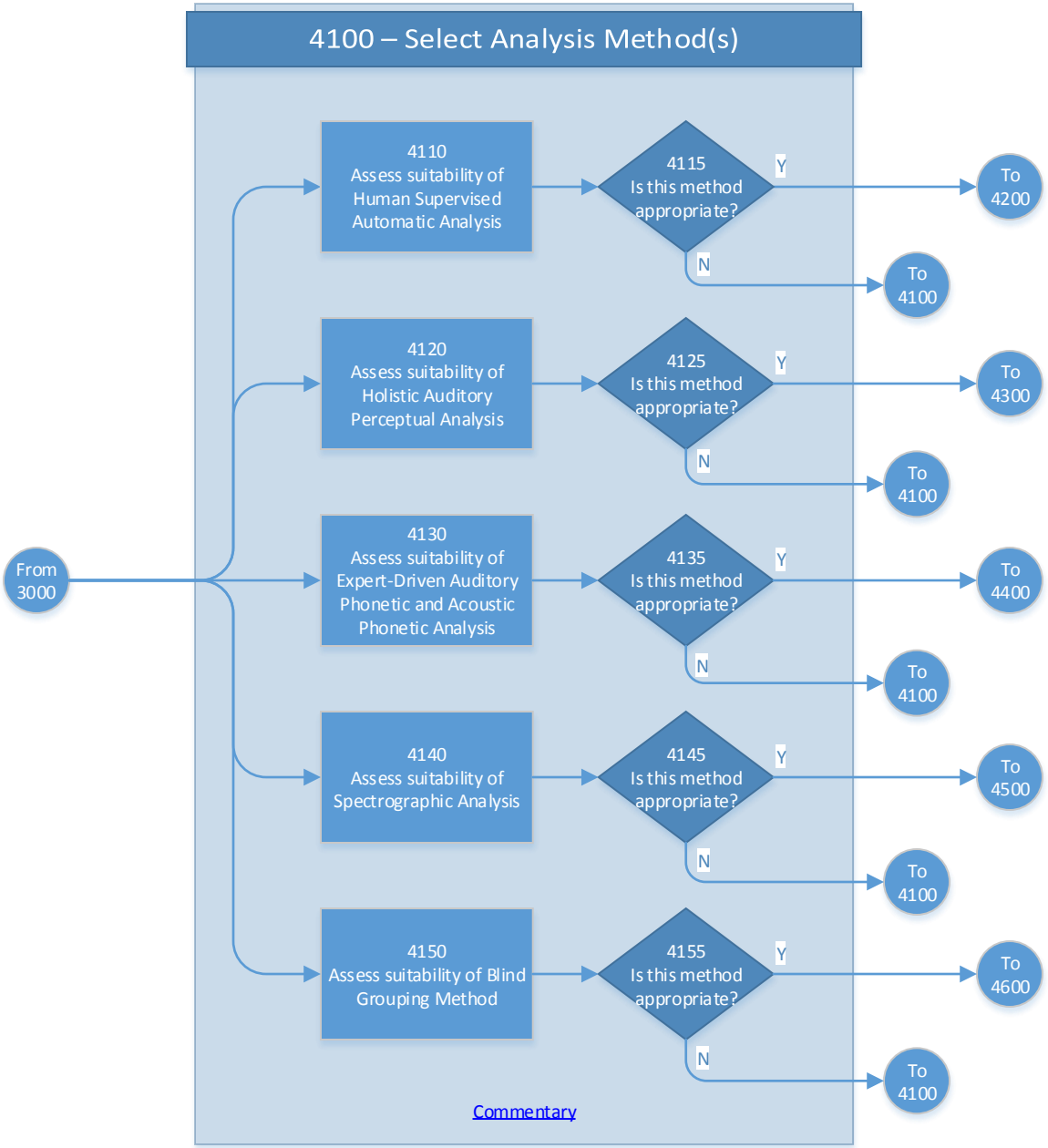
To 5300

Commentary

Legend

▭	Single process step
▭	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
◇	Decision step
▭	Process step that results in documentation
○	Indicates that the next or previous step is somewhere else on the process map

Return to Overview



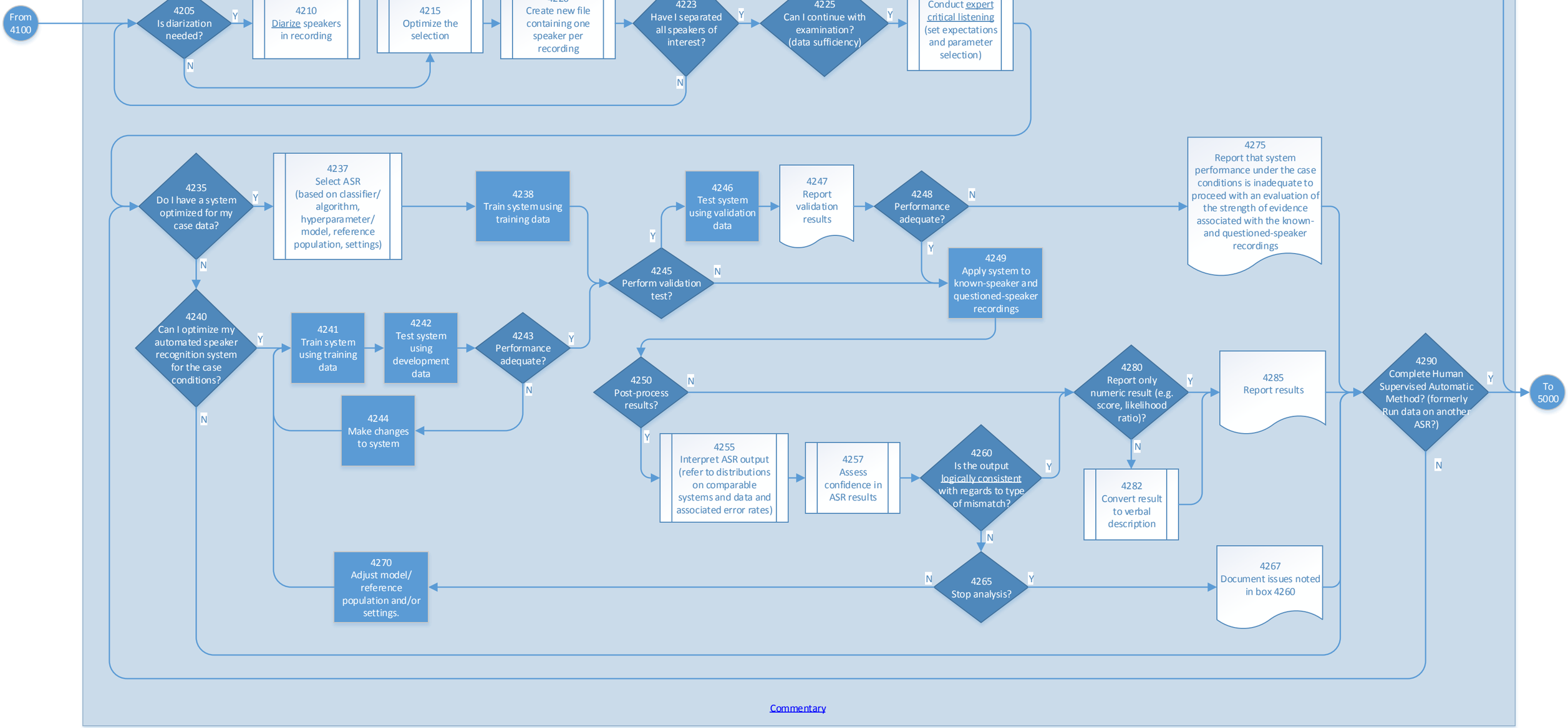
Acoustic Phonetic Statistical Analysis (Semiautomatic Analysis)

Acoustic Phonetic Statistical Analysis (or Semiautomatic Analysis) is similar to Human Supervised Automatic Analysis (4200), but uses features derived via phonetic analysis, including human-supervised measurements of acoustic properties of the speech recording.

Legend	
▭	Single process step
◇	Decision step
○	Indicates that the next or previous step is somewhere else on the process map

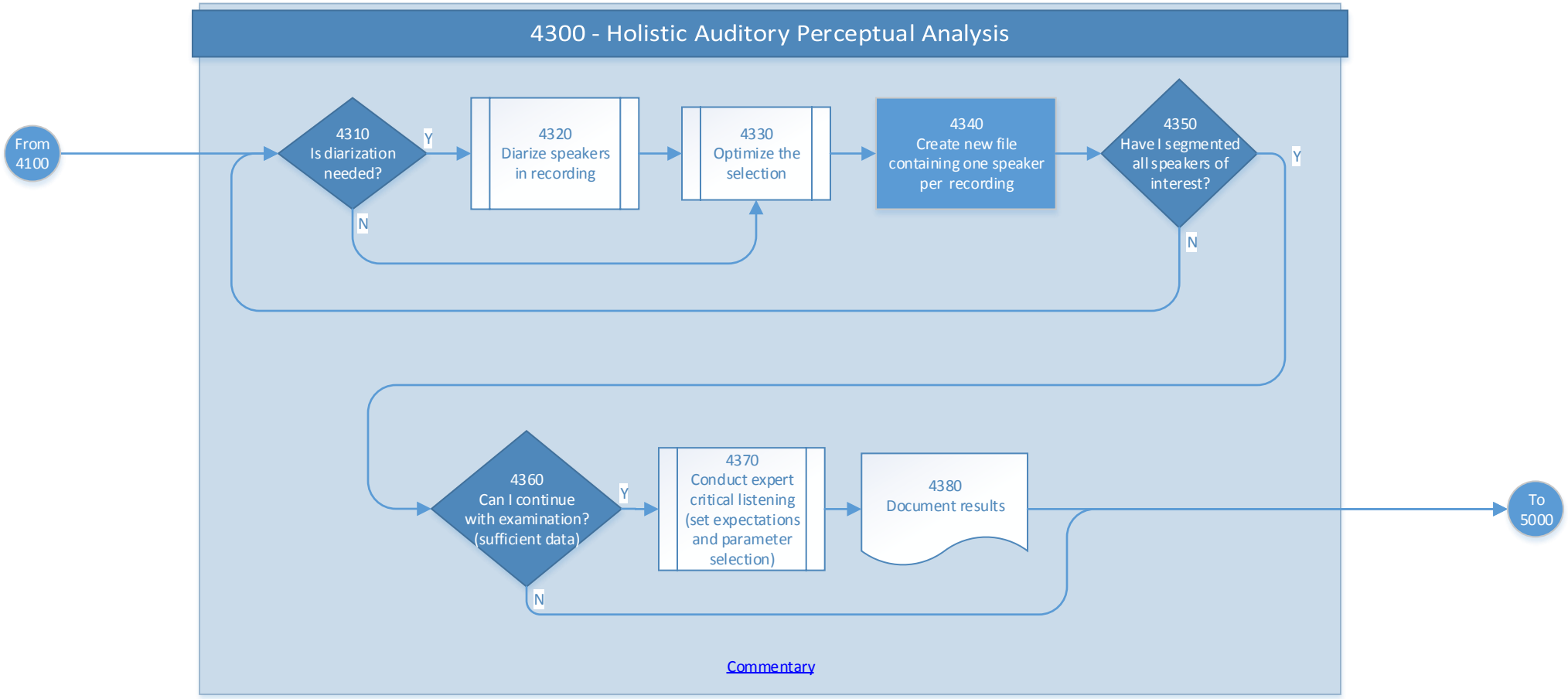
Return to Overview 4000

4200 - Human Supervised Automatic Analysis



Commentary

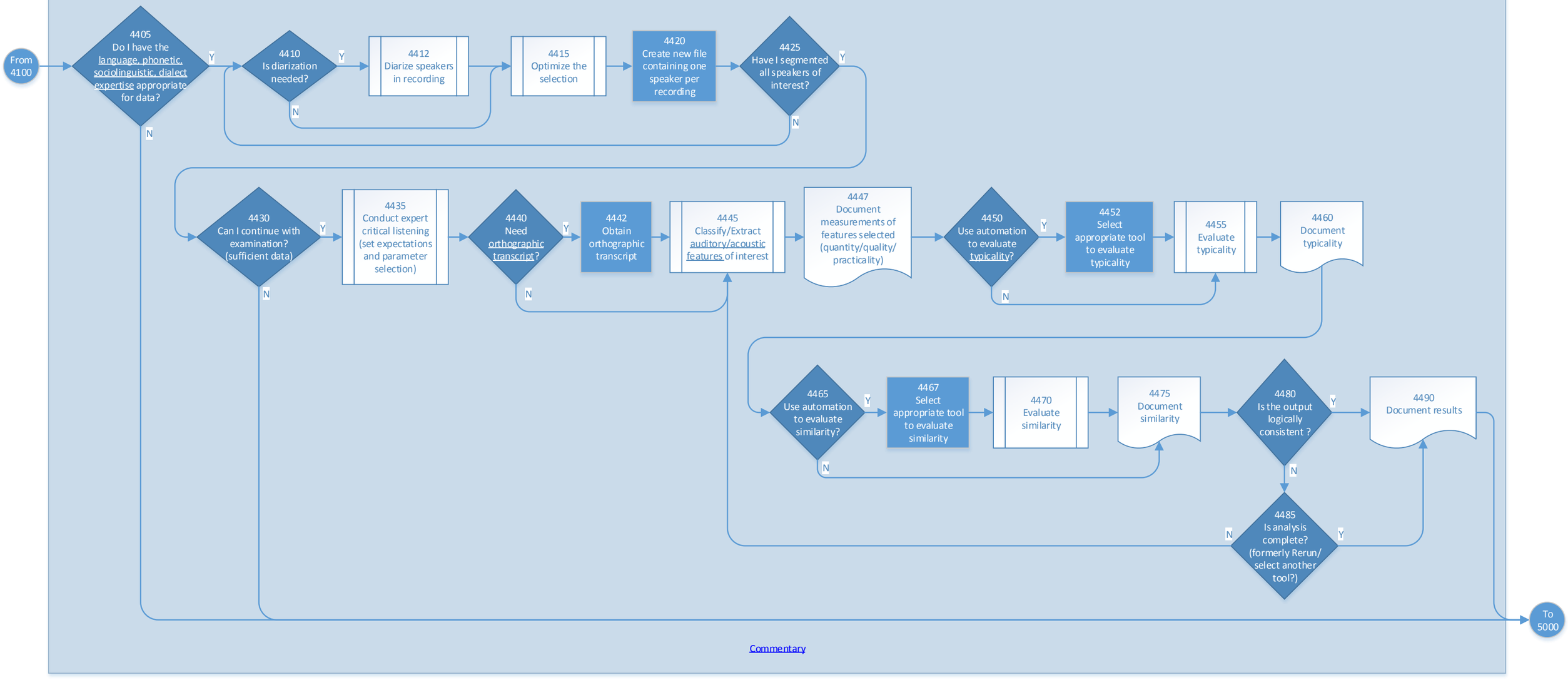
Return to Overview 4000



Legend	
	Single process step
	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
	Decision step
	Process step that results in documentation
	Indicates that the next or previous step is somewhere else on the process map

Return to Overview 4000

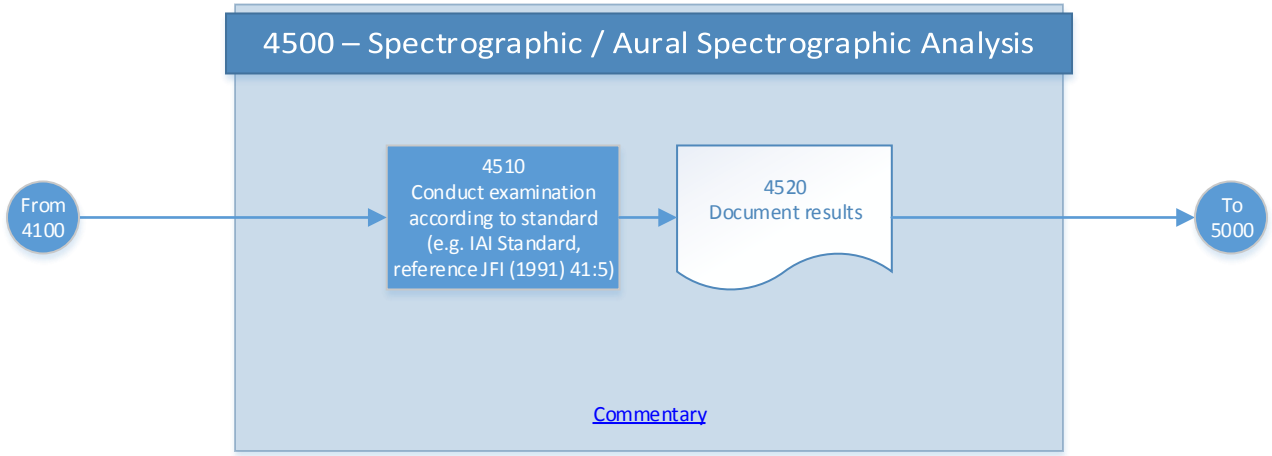
4400 - Expert Driven Auditory Phonetic & Acoustic Phonetic Analysis



Commentary

Legend	
	Single process step
	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
	Decision step
	Process step that results in documentation
	Indicates that the next or previous step is somewhere else on the process map

Return to Overview 4000



Legend	
	Single process step
	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
	Indicates that the next or previous step is somewhere else on the process map

Return to Overview 4000

4600 – Blind Grouping Method

Researcher #1

From 4100

4605 Are there appropriate foils available in the case? (Y / N)

4610 Create a list of speakers to be included in the blind grouping, containing at least each Q, and K and 0 or more foils.

4615 Is diarization needed? (Y / N)

4620 Diarize speakers in recordings

4625 Optimize the selection

4630 Create new file per speaker per recording. Strip the recording from any speech that contains name, addresses, etc. that would help linking fragments.

4635 Is it possible to make 1 or more fragments of max 20 seconds for each speaker and each recording? (Y / N)

4640 Is it possible to make true same speaker and true different speaker pairs? (Y / N)

4645 Create a list of fragments per speaker per recording, max 20 fragments.

4650 Create the max 20 fragments into separate audio files, all with the same audio specs (take the one with the highest quality).

4655 Is there enough speaker variation in each of the fragments (so as not to bias by selection)? (Y / N)

4660 Anonymize and collect all the fragments in one larger audio file in random order (but make a lookup table to retrieve the origins). Present the larger file to researcher #2.

4665 Document composition of larger audio file.

Researcher #2

4670 Compare each of the fragments with each other and group them by perceived speaker identity.

4675 Is each of the fragments suitable for grouping? (N / Y)

4680 Separate out the unsuitable fragments.

4685 Document a grouping, including perceived similarity within groups and perceived dissimilarity between groups and the ungrouped fragments.

Researchers #1 and #2

4690 Interpret grouping using lookup table and including correctness of grouping in ground truth.

4695 Document results

To 5000

Commentary

Legend

▭	Single process step
▯	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
◇	Decision step
▭ (wavy)	Process step that results in documentation
○	Indicates that the next or previous step is somewhere else on the process map

Return to Overview

5100 – Evaluation / Generating Conclusion

From 4000

5105 Multiple methods used? (Y / N)

5110 Assess confidence for each method used

5115 Combine (fuse) results? (Y / N)

5120 Assign weight and combine (fuse) results per agency policy

5125 Formulate conclusion

5150 Will consultation be helpful? (Y / N)

5155 Share case detail Seek input

5160 Will additional analysis be helpful? (Y / N)

5165 Document Opinion or Conclusions

5170 Are all case questions answered? (Y / N)

To 3000

5180 Draft preliminary report

To 4000

Commentary

5200 - Verification

5205 Verify conclusions? (according to agency policy) (Y / N)

5210 Conduct blind review? (Y / N)

5220 Conduct fully blinded? (Y / N)

5225 Share limited case data (per agency policy)

5230 Conduct technical review (per agency policy)

5240 Conduct independent analysis (examiner begins at 310)

5250 Consensus conclusion reached? (Y / N)

5260 Resolve conflicts (Follow agency conflict resolution policy)

5270 Does the report need to be changed? (Y / N)

5280 Revise Report based on consensus review

5290 Conduct administrative review

Commentary

5300 - Case Close-Out

Abort

5310 Notify requestor and transmit report, where appropriate

Terminate Review

Commentary

Legend

▭	Single process step
▯	Multistep process that may be pre-defined in a standard, by lab policy, and/or by examiners
◇	Decision step
⌒	Process step that results in documentation
○	Indicates that the next or previous step is somewhere else on the process map

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Process Step
1000 – Administrative Assessment
Description
Terms and Definitions
Comments
Issues
References
Revised
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Return to Overview 1000 1100

Process Step
1100 – Case Suitability
Description
Terms and Definitions
Comments
Issues
References
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Return to Overview 1000 1200

Process Step
1200 – Case Acceptance
Description
Terms and Definitions
Comments
Issues
References
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Process Step
2000 – Technical Assessment
Description
Terms and Definitions
Comments
Issues
References
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Process Step
2100 – Preliminary Evaluation
Description
Terms and Definitions
Comments
Issues
References
SWGDE Best Practices for Forensic Audio.
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Process Step
2200 – Content Review
Description
Terms and Definitions
Comments
Issues
References
Revised
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Return to Overview 3000

Process Step
3000 – Processing
Description
Terms and Definitions
Comments
Issues
References
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Return to Overview 3000 3100

Process Step
3100 – Pre-Analysis Observations and Processing
Description
Terms and Definitions
3155: Types of processing • Enhancement for intelligibility or listenability (e.g. tone removal, spectral shaping, adaptive filtering, etc.) • Normalization • Convert sampling rate / bit depth • Channel conversion • DC offset • Anti-aliasing
Comments
Issues
References
Revised
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Return to Overview 3000 3200

Process Step
3200 – Relevant Population Data

Description
This block describes the necessary use of different data sets for testing system performance. Evaluation typically requires training data and test data sets, but other data may be required (e.g. for calibration).

Term ands Definitions

Comments

Issues

References

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §3.1. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Morrison, G.S., Enzinger, E., Zhang, C. (2016). Refining the relevant population in forensic voice comparison – A response to Hicks et alii (2015) The importance of distinguishing information from evidence/observations when formulating propositions. *Science & Justice*, 56, 492–497. http://dx.doi.org/10.1016/j.scijus.2016.07.002 [see also: http://geoff-morrison.net/#replies_to_Hicks_et_al_2015]

Robertson B., Vignaux G.A., Berger C.E.H. (2016). *Interpreting Evidence: Evaluating Forensic Science in the Courtroom*, 2nd Ed., Chichester (UK): Wiley. http://dx.doi.org/10.1002/9781118492475

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Return to Overview 4000

Process Step

4000 – Analysis

Description

Terms and Definitions

Comments

Issues

References

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §2.3. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Morrison, G.S. (2018). Admissibility of forensic voice comparison testimony in England and Wales. *Criminal Law Review*, (1), 20–33. (Available: http://geoff-morrison.net/#Admissibility_EW_2018)

Morrison, G.S. (2014). Distinguishing between forensic science and forensic pseudoscience: Testing of validity and reliability, and approaches to forensic voice comparison. *Science & Justice*, 54, 245–256. http://dx.doi.org/10.1016/j.scijus.2013.07.004

Revised

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Return to Overview 4000 4100

Process Step
4100 – Select Analysis Method(s)

Description

Terms and Definitions

Comments

Issues

References
For Acoustic Phonetic Statistical Analysis (Semiautomatic Analysis): Rose P. (2002). Forensic speaker identification. London: Taylor and Francis. Rose P. (2013). Where the science ends and the law begins - likelihood ratio-based forensic voice comparison in a $150 million telephone fraud. International Journal of Speech, Language and the Law, pp. 227-324. http://dx.doi.org/10.1558/ijsll.v20i2.277 Rose P. (2017). Likelihood ratio-based forensic voice comparison with higher level features research and reality. Computer Speech & Language, 45, pp. 475-502. http://dx.doi.org/10.1016/j.csl.2017.03.003

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Return to Overview 4000 4200

Process Step

4200 – Human Supervised Automatic Analysis

Description

This block describes the necessary use of different data sets for testing system performance. Evaluation typically requires training data and test data sets, but other data may be required (e.g. for calibration).

Terms and Definitions

4230: "Expert critical listening" is defined as ...

Comments

Issues

References

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §2.3.4. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Morrison G.S., Enzinger E. (2016). Multi-laboratory evaluation of forensic voice comparison systems under conditions reflecting those of a real forensic case (forensic_eval_01) – Introduction, *Speech Communication*, 85, pp. 119–126. http://dx.doi.org/10.1016/j.specom.2016.07.006

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Return to Overview 4000 4300

Process Step
4300 – Holistic Auditory Perceptual Analysis
Description
Terms and Definitions
Comments
Issues
References
Revised
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Return to Overview 4000 4400

Process Step
4400 – Expert Driven Auditory Phonetic and Acoustic Phonetic Analysis

Description

Terms and Definitions

Comments

Issues

References

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §2.3.1 §2.3.3. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Lindh J. (2017). Forensic comparison of voices, speech and speakers tools and methods in forensic phonetics. PhD dissertation. University of Gothenburg.

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Return to Overview 4000 4500

Process Step
4500 – Spectrographic / Aural Spectrographic Analysis

Description

Terms and Definitions

Comments

Issues

References

IAI Standard, reference JFI (1991) 41:5

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §2.3.2. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Cáo Hónglín 曹洪林, Lǐ Jìngyáng 李敬陽, Wáng Yīnglì 王英利, Kǒng Jiāngpíng孔江平 (2013). Lùn shēngwén jiàndìng yìjiàn de biǎoshù xíngshì 論聲紋鑒定意見的表述形式 [On Expert Opinion of Forensic Speaker Identification], Zhèngjù Kēxué 證據科學 [Evidence Science], 21, 605–624

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Return to Overview 4000 4600

Process Step
4600 – Blind Grouping Method
Description
Terms and Definitions
Comments
Issues
References
Cambier-Langeveld T., van Rossum M. and Vermeulen J. 2014. Whose voice is that? Challenges in forensic phonetics. In van Heuven V. and Caspers J., editors, *Above and Beyond the Segments: Experimental Linguistics and Phonetics*, pages 14–27. John Benjamins, Amsterdam.
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Return to Overview 5000

Process Step
5000 – Results
Description
Terms and Definitions
Comments
Issues
References
Revised
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Return to Overview 5000 5100

Process Step

5100 – Evaluation / Generating Conclusion

Description

Terms and Definitions

Comments

References

Morrison, G.S., Thompson, W.C. (2017). Assessing the admissibility of a new generation of forensic voice comparison testimony. *Columbia Science and Technology Law Review*, 18, 326–434 §3. http://www.stlr.org/cite.cgi?volume=18&article=morrisonThompson (Preprints: https://ssrn.com/abstract=2883767 https://www.newton.ac.uk/files/preprints/ni16053.pdf)

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Process Step
5200 – Verification
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Process Step
5300 – Case Close-Out
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