

Introduction

The National Institute of Standards and Technology (NIST) facilitated the development of this Firearms Process Map through a collaboration between the NIST Forensic Science Research Program and the NIST administered Organization of Scientific Area Committees (OSAC) for Forensic Sciences (specifically OSAC's Firearms and Toolmarks Subcommittee) in partnership with the Association of Firearm and Tool Mark Examiners (AFTE).

This Firearms Process Map (Current Practices) captures details about the various procedures, methods and decision points most frequently encountered in the discipline of firearm examination from a national and international perspective and **is intended to reflect current practices**. The discipline of firearm examination requires examiners to make many decisions that can impact the quality and accuracy of results. The Firearms Process Map can benefit the firearm examination discipline by providing a behind-the-scenes perspective into the various components and decision points in the firearms analysis process.

Process mapping is the visual representation of critical steps and decision points of a process. Components of the process are deconstructed, placed into specific shapes within a flowchart and connected by one-way arrows to indicate directionality regarding decisions as well as progression throughout the overall process. The shape of each box assists the reader by representing a specific type of activity.

This process map captures the **diverse** practices of multiple laboratories, with the goal of allowing a firearm examiner to find their process represented in the map. To ensure this, the mapping team avoided creating a map of what **should** be done (e.g., best practices) and instead attempted to represent all reasonable variations of casework **currently performed** by firearm examiners. For this reason, it is important to state that neither the OSAC Firearms and Toolmarks Subcommittee nor AFTE necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.

This map is not intended to be a step-by-step instruction manual outlining minutia, nor is it intended to be so broad that it lacks utility. Rather, judgements were made by the process mapping group as to which steps should be combined and which steps should be divided further. Certain processes represented in the map have a required sequence while other components may vary by examiner or agency. Processes and decisions may also be dictated by agency policy or law.

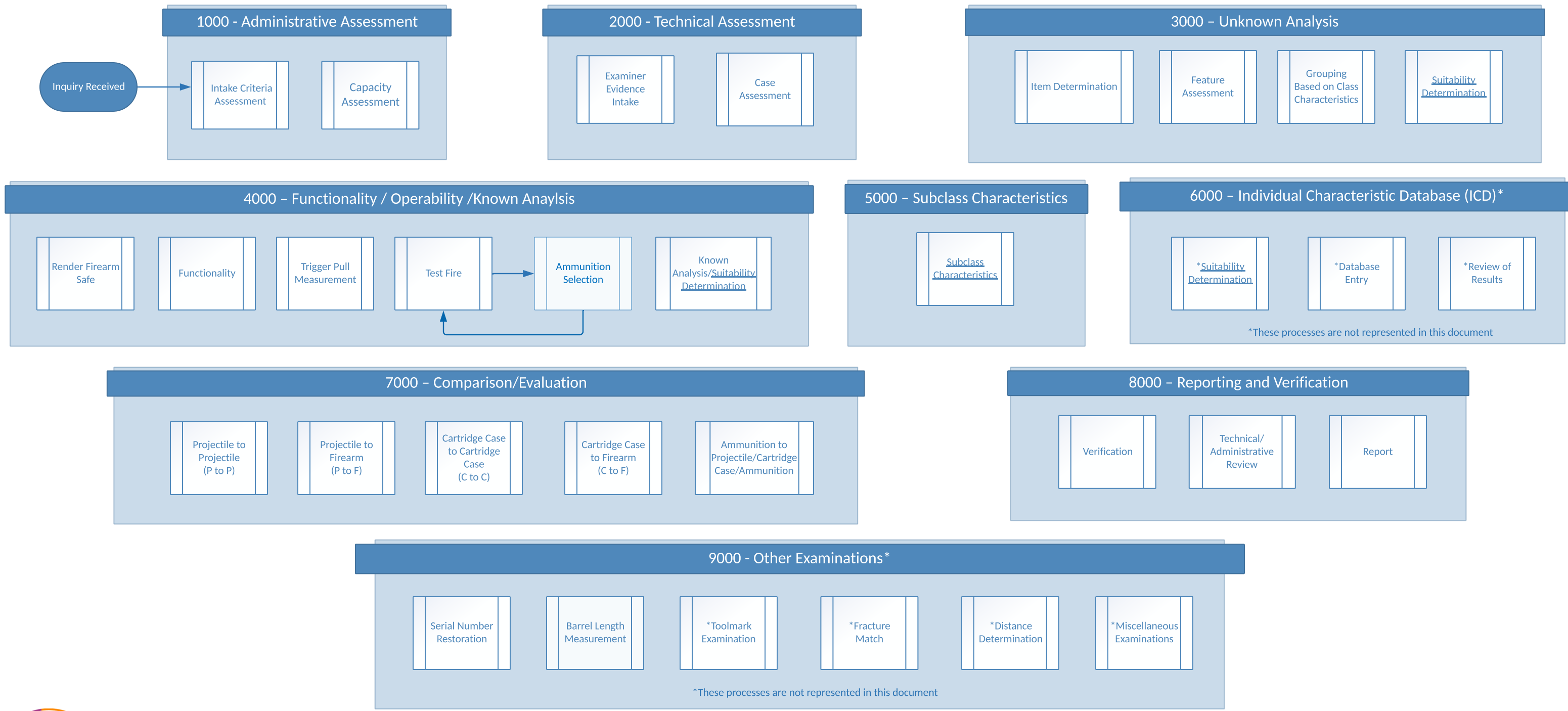
Process Map Applications:

The Firearms Process Map is intended to be used to help improve efficiencies while reducing errors, highlight gaps where further research or standardization would be beneficial, and assist with training new examiners. It may also be used to develop specific laboratory policies and identify best practices.

Scope of the Firearms Process Map:

The scope of Firearms Process map is limited to core processes within the discipline of firearm and toolmark examination such as the examination of firearms and the microscopic comparison of fired ammunition components. Several topics are omitted from this map to include individual characteristic databases, toolmark examination, fracture matching and distance determination. These topics may subsequently be addressed by the process mapping team, an individual laboratory or a standardization committee.





Underlined Word
Word that will be defined in the glossary

Technology Assist
Technology that aids in the steps on this page

Input Box
Outlines the inputs at the beginning of each section

Output Box
Describes an output of the steps on the page

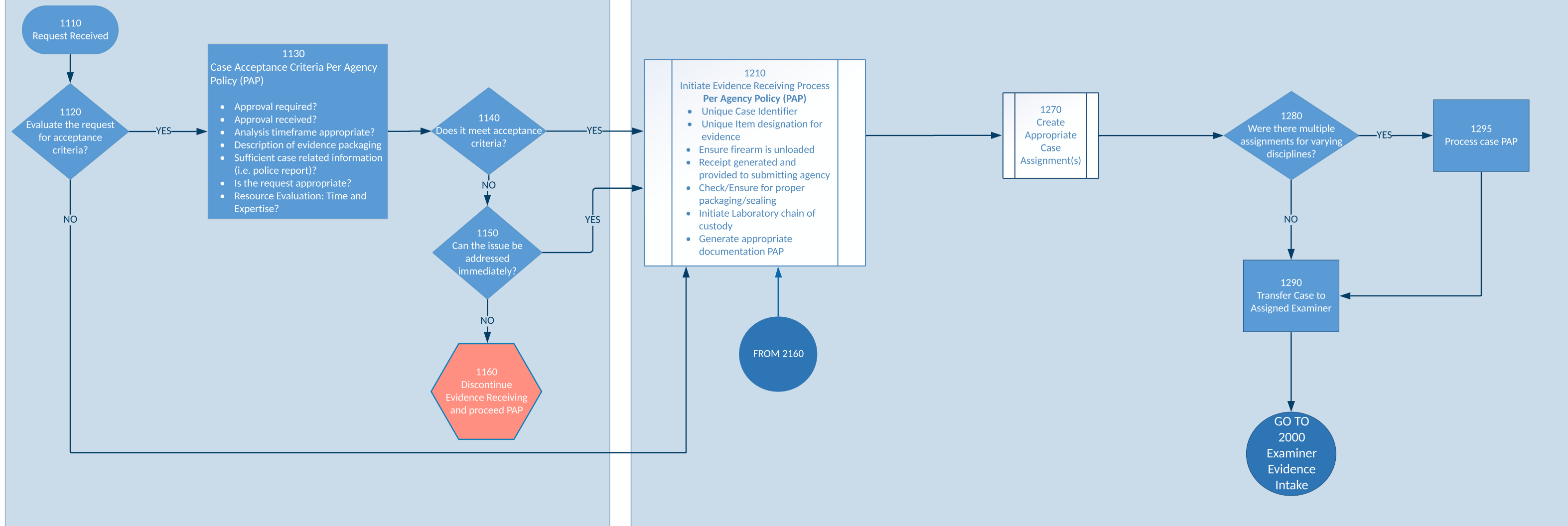
Discontinuation of Assessment or Examination

Legend	
	Process start/end
	Process
	Decision
	Subprocess
	Document

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1100 - Intake Criteria Assessment

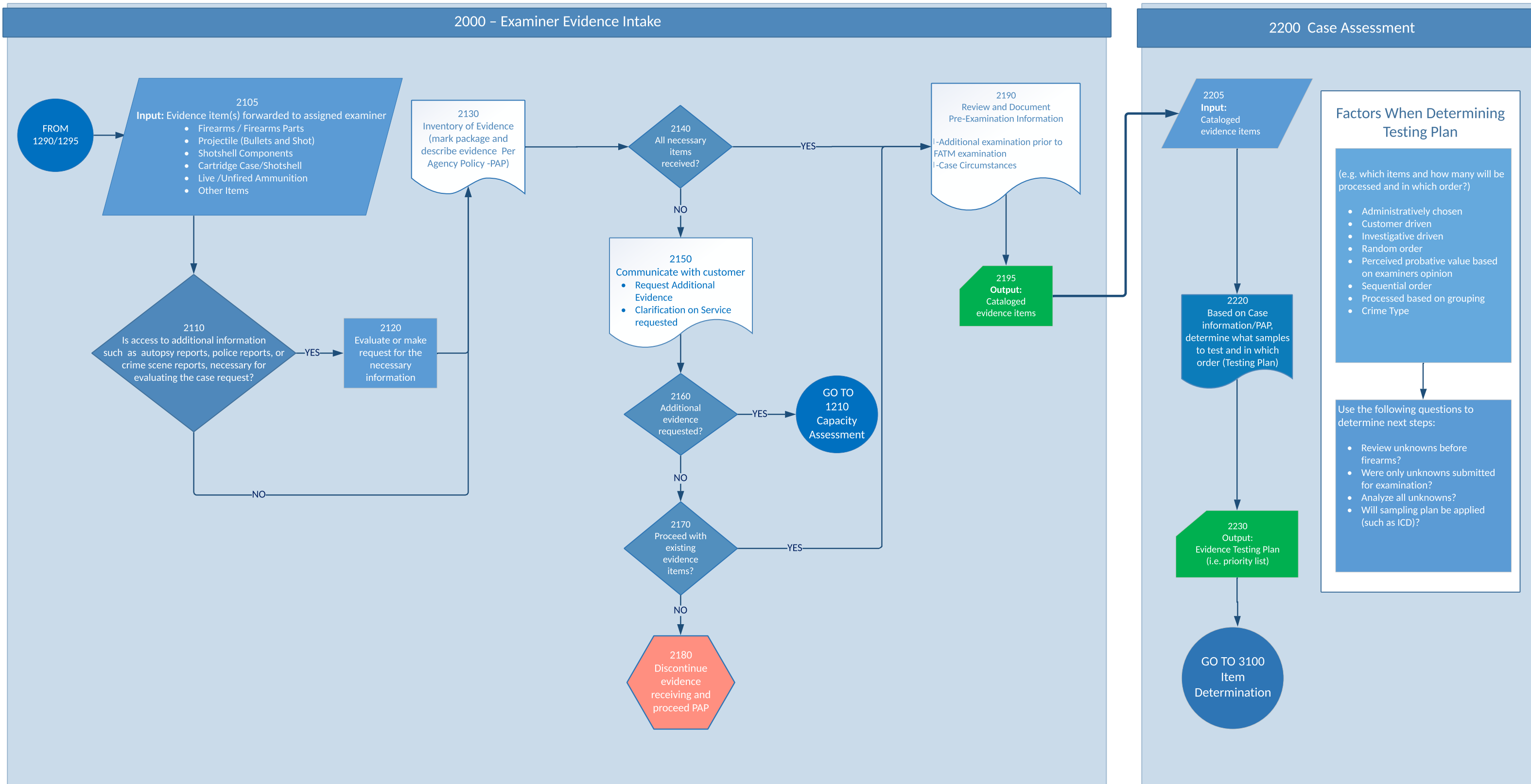
1200 - Capacity Assessment



Technology Assist

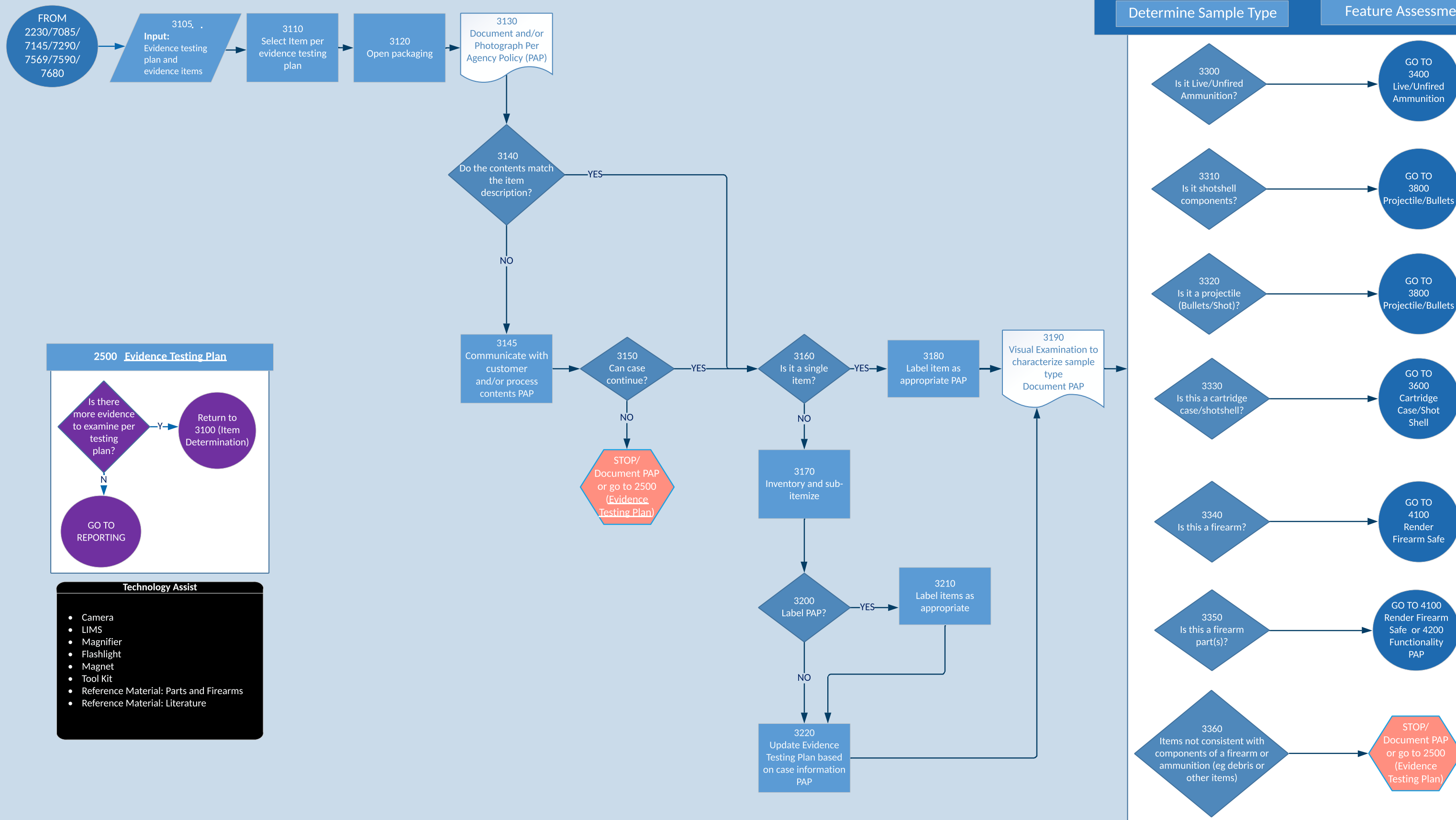
- LIMS

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3100 Item Determination



2500 Evidence Testing Plan

Is there more evidence to examine per testing plan?

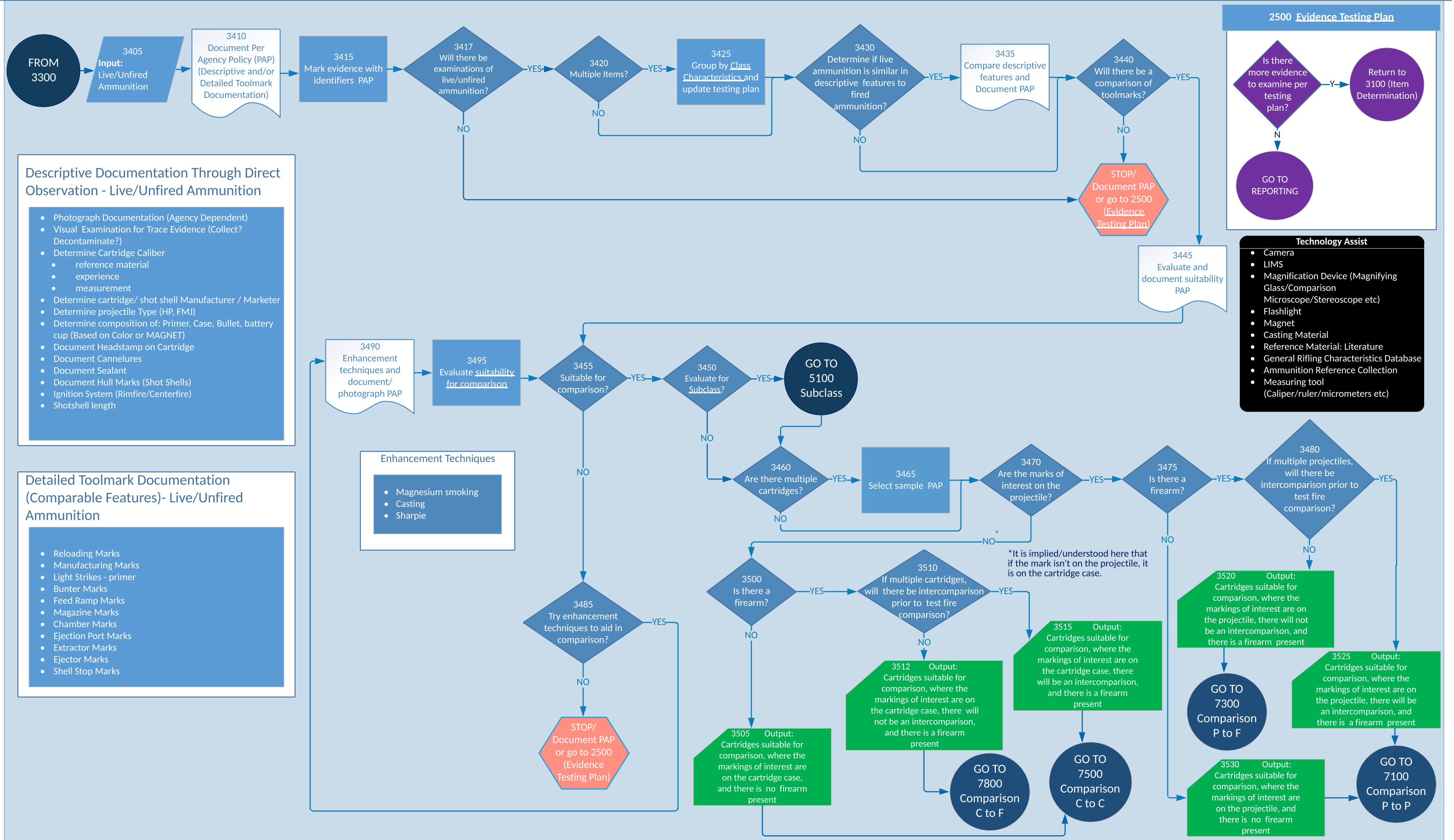
Y → Return to 3100 (Item Determination)

N → GO TO REPORTING

- Technology Assist**
- Camera
 - LIMS
 - Magnifier
 - Flashlight
 - Magnet
 - Tool Kit
 - Reference Material: Parts and Firearms
 - Reference Material: Literature

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3400 Feature Assessment: Live/Unfired Ammunition



Descriptive Documentation Through Direct Observation - Live/Unfired Ammunition

- Photograph Documentation (Agency Dependent)
- Visual Examination for Trace Evidence (Collect? Decontaminate?)
- Determine Cartridge Caliber
 - reference material
 - experience
 - measurement
- Determine cartridge/ shot shell Manufacturer / Marketer
- Determine projectile Type (HP, FMJ)
- Determine composition of: Primer, Case, Bullet, battery cup (Based on Color or MAGNET)
- Document Headstamp on Cartridge
- Document Cannelures
- Document Sealant
- Document Hull Marks (Shot Shells)
- Ignition System (Rimfire/Centerfire)
- Shotshell length

Detailed Toolmark Documentation (Comparable Features)- Live/Unfired Ammunition

- Reloading Marks
- Manufacturing Marks
- Light Strikes - primer
- Bunter Marks
- Feed Ramp Marks
- Magazine Marks
- Chamber Marks
- Ejection Port Marks
- Extractor Marks
- Ejector Marks
- Shell Stop Marks

Enhancement Techniques

- Magnesium smoking
- Casting
- Sharpie

2500 Evidence Testing Plan

Is there more evidence to examine per testing plan?

Y → Return to 3100 (Item Determination)

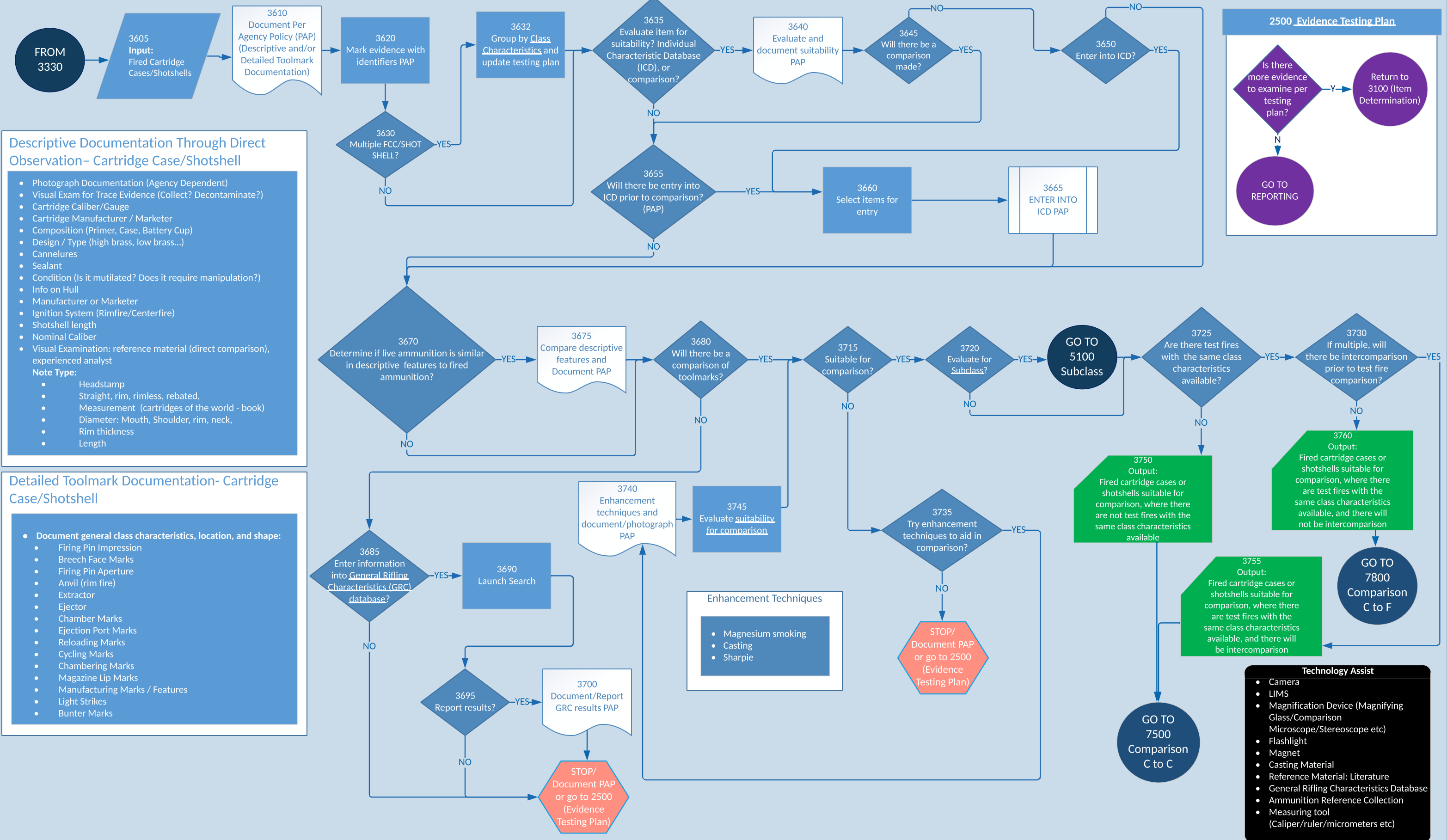
N → GO TO REPORTING

Technology Assist

- Camera
- LIMS
- Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc)
- Flashlight
- Magnet
- Casting Material
- Reference Material: Literature
- General Rifling Characteristics Database
- Ammunition Reference Collection
- Measuring tool (Caliper/ruler/micrometers etc)

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3600 Feature Assessment: Cartridge Cases/Shotshells



Descriptive Documentation Through Direct Observation- Cartridge Case/Shotshell

- Photograph Documentation (Agency Dependent)
- Visual Exam for Trace Evidence (Collect? Decontaminate?)
- Cartridge Caliber/Gauge
- Cartridge Manufacturer / Marketer
- Composition (Primer, Case, Battery Cup)
- Design / Type (high brass, low brass...)
- Cannelures
- Sealant
- Condition (Is it mutilated? Does it require manipulation?)
- Info on Hull
- Manufacturer or Marketer
- Ignition System (Rimfire/Centerfire)
- Shotshell length
- Nominal Caliber
- Visual Examination: reference material (direct comparison), experienced analyst

Note Type:

- Headstamp
- Straight, rim, rimless, rebated,
- Measurement (cartridges of the world - book)
- Diameter: Mouth, Shoulder, rim, neck,
- Rim thickness
- Length

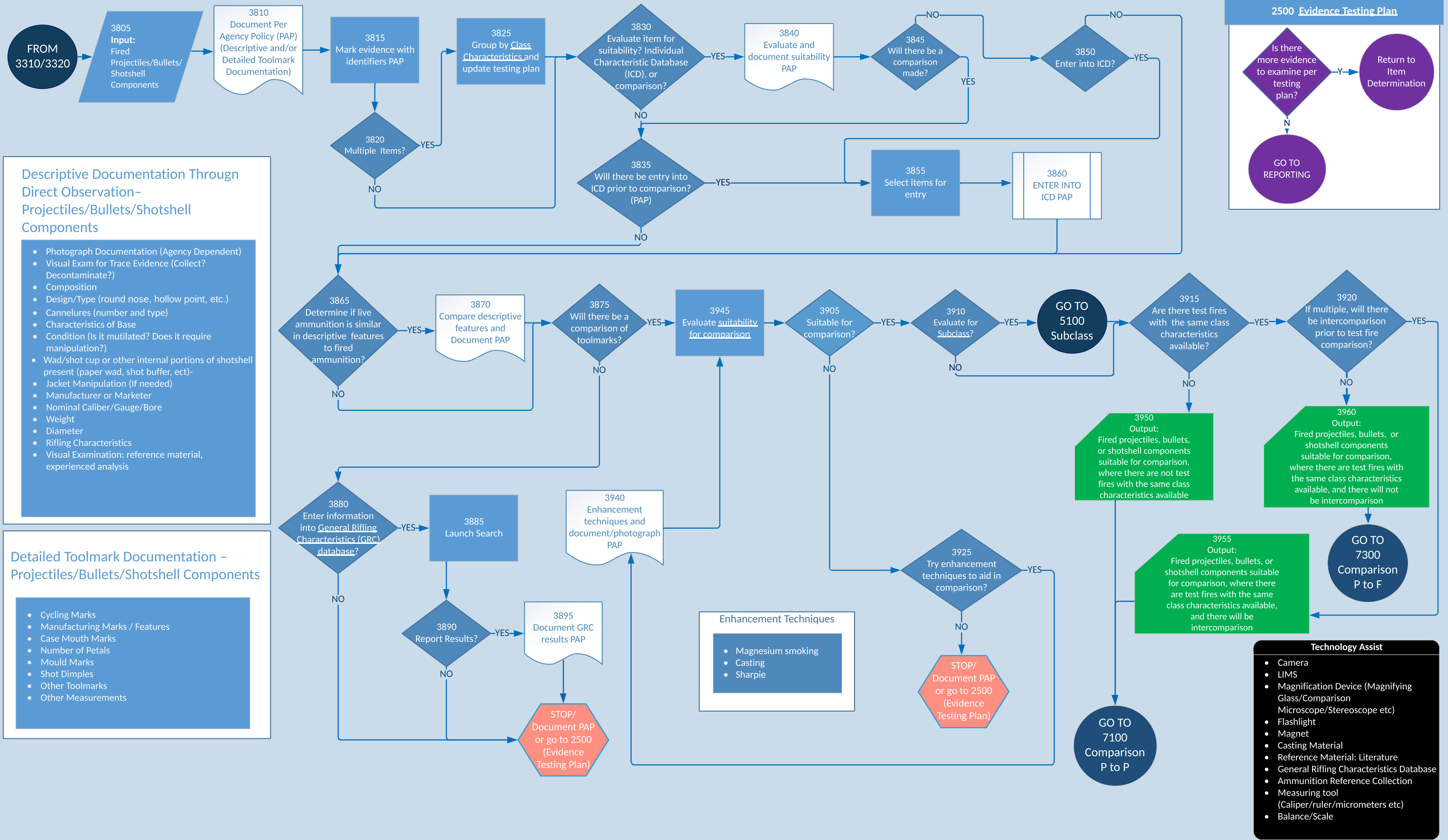
Detailed Toolmark Documentation- Cartridge Case/Shotshell

- Document general class characteristics, location, and shape:
 - Firing Pin Impression
 - Breech Face Marks
 - Firing Pin Aperture
 - Anvil (rim fire)
 - Extractor
 - Ejector
 - Chamber Marks
 - Ejection Port Marks
 - Reloading Marks
 - Cycling Marks
 - Chambering Marks
 - Magazine Lip Marks
 - Manufacturing Marks / Features
 - Light Strikes
 - Bunter Marks

- #### Technology Assist
- Camera
 - LIMS
 - Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc)
 - Flashlight
 - Magnet
 - Casting Material
 - Reference Material: Literature
 - General Rifling Characteristics Database
 - Ammunition Reference Collection
 - Measuring tool (Caliper/ruler/micrometers etc)

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3800 Feature Assessment: Projectiles/Bullets



Descriptive Documentation Through Direct Observation - Projectiles/Bullets/Shotshell Components

- Photograph Documentation (Agency Dependent)
- Visual Exam for Trace Evidence (Collect? Decontaminate?)
- Composition
- Design/Type (round nose, hollow point, etc.)
- Cannelures (number and type)
- Characteristics of Base
- Condition (Is it mutilated? Does it require manipulation?)
- Wad/shot cup or other internal portions of shotshell present (paper wad, shot buffer, ect)-
- Jacket Manipulation (If needed)
- Manufacturer or Marketer
- Nominal Caliber/Gauge/Bore
- Weight
- Diameter
- Rifling Characteristics
- Visual Examination: reference material, experienced analysis

Detailed Toolmark Documentation - Projectiles/Bullets/Shotshell Components

- Cycling Marks
- Manufacturing Marks / Features
- Case Mouth Marks
- Number of Petals
- Mould Marks
- Shot Dimples
- Other Toolmarks
- Other Measurements

Enhancement Techniques

- Magnesium smoking
- Casting
- Sharpie

2500 Evidence Testing Plan

Is there more evidence to examine per testing plan?

Y → Return to Item Determination

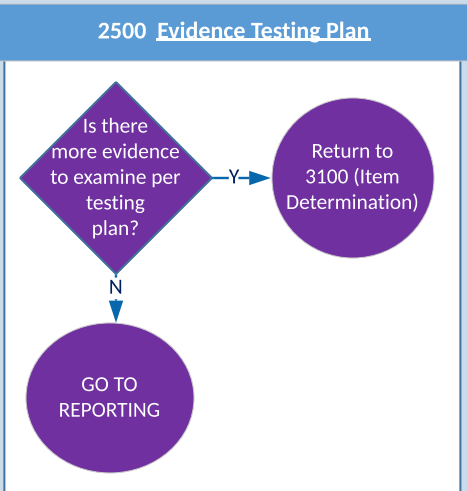
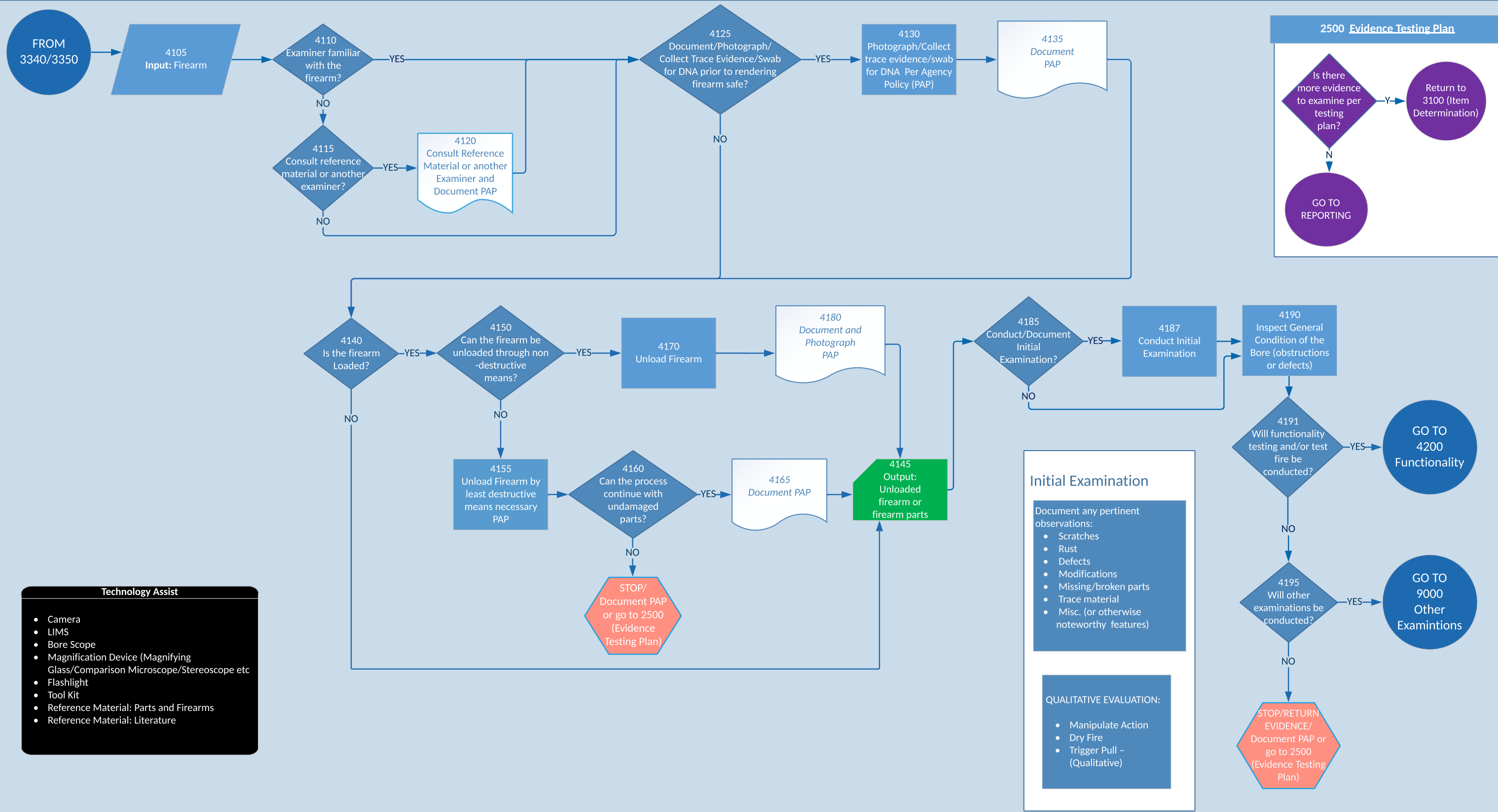
N → GO TO REPORTING

Technology Assist

- Camera
- LIMS
- Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc)
- Flashlight
- Magnet
- Casting Material
- Reference Material: Literature
- General Rifling Characteristics Database
- Ammunition Reference Collection
- Measuring tool (Caliper/ruler/micrometers etc)
- Balance/Scale

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4100 Render Firearm Safe



Initial Examination

Document any pertinent observations:

- Scratches
- Rust
- Defects
- Modifications
- Missing/broken parts
- Trace material
- Misc. (or otherwise noteworthy features)

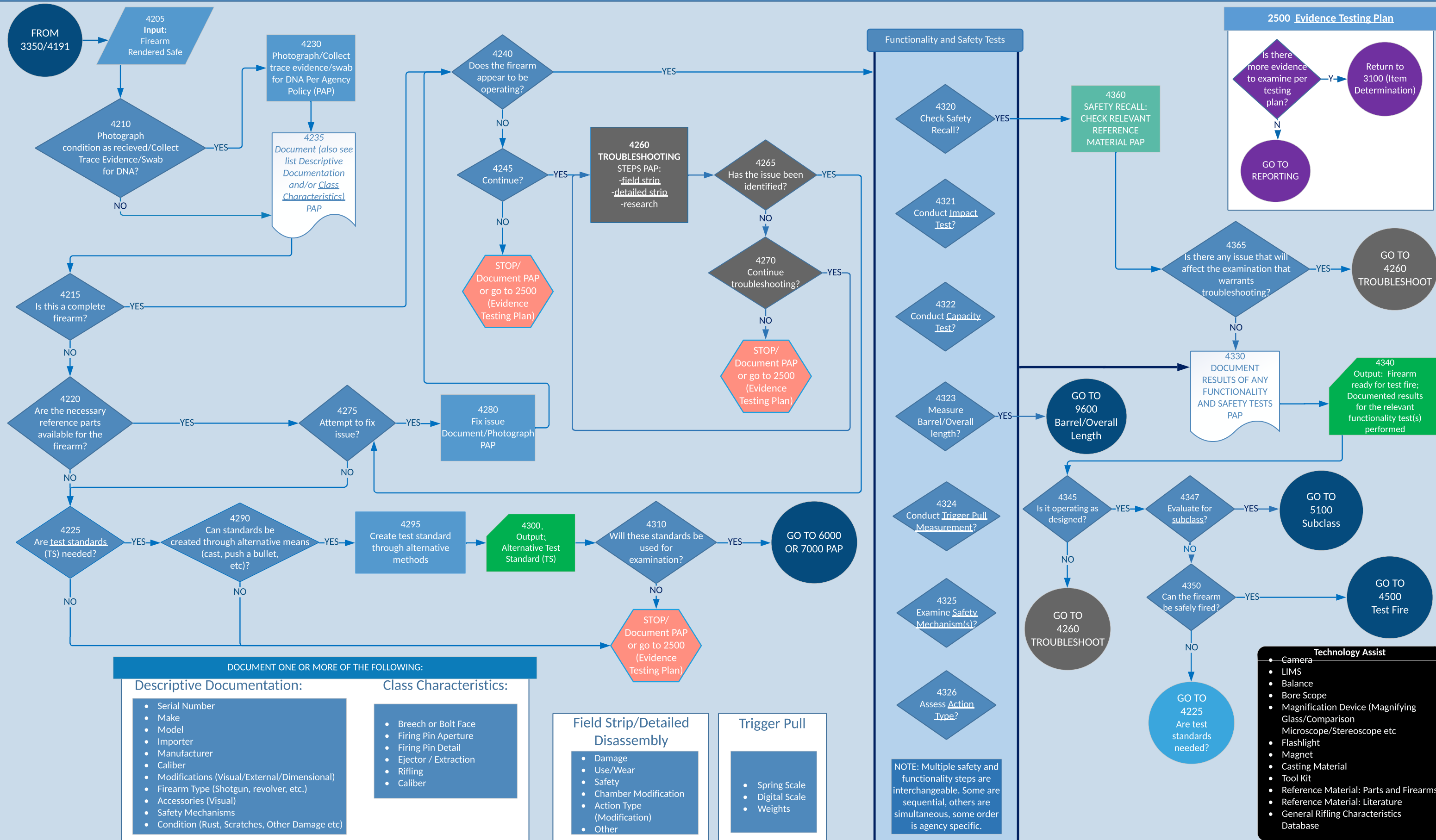
QUALITATIVE EVALUATION:

- Manipulate Action
- Dry Fire
- Trigger Pull – (Qualitative)

- Technology Assist**
- Camera
 - LIMS
 - Bore Scope
 - Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc)
 - Flashlight
 - Tool Kit
 - Reference Material: Parts and Firearms
 - Reference Material: Literature

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4200 Functionality



DOCUMENT ONE OR MORE OF THE FOLLOWING:

<p>Descriptive Documentation:</p> <ul style="list-style-type: none"> Serial Number Make Model Importer Manufacturer Caliber Modifications (Visual/External/Dimensional) Firearm Type (Shotgun, revolver, etc.) Accessories (Visual) Safety Mechanisms Condition (Rust, Scratches, Other Damage etc) 	<p>Class Characteristics:</p> <ul style="list-style-type: none"> Breech or Bolt Face Firing Pin Aperture Firing Pin Detail Ejector / Extraction Rifling Caliber
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<p>Field Strip/Detailed Disassembly</p> <ul style="list-style-type: none"> Damage Use/Wear Safety Chamber Modification Action Type (Modification) Other 	<p>Trigger Pull</p> <ul style="list-style-type: none"> Spring Scale Digital Scale Weights
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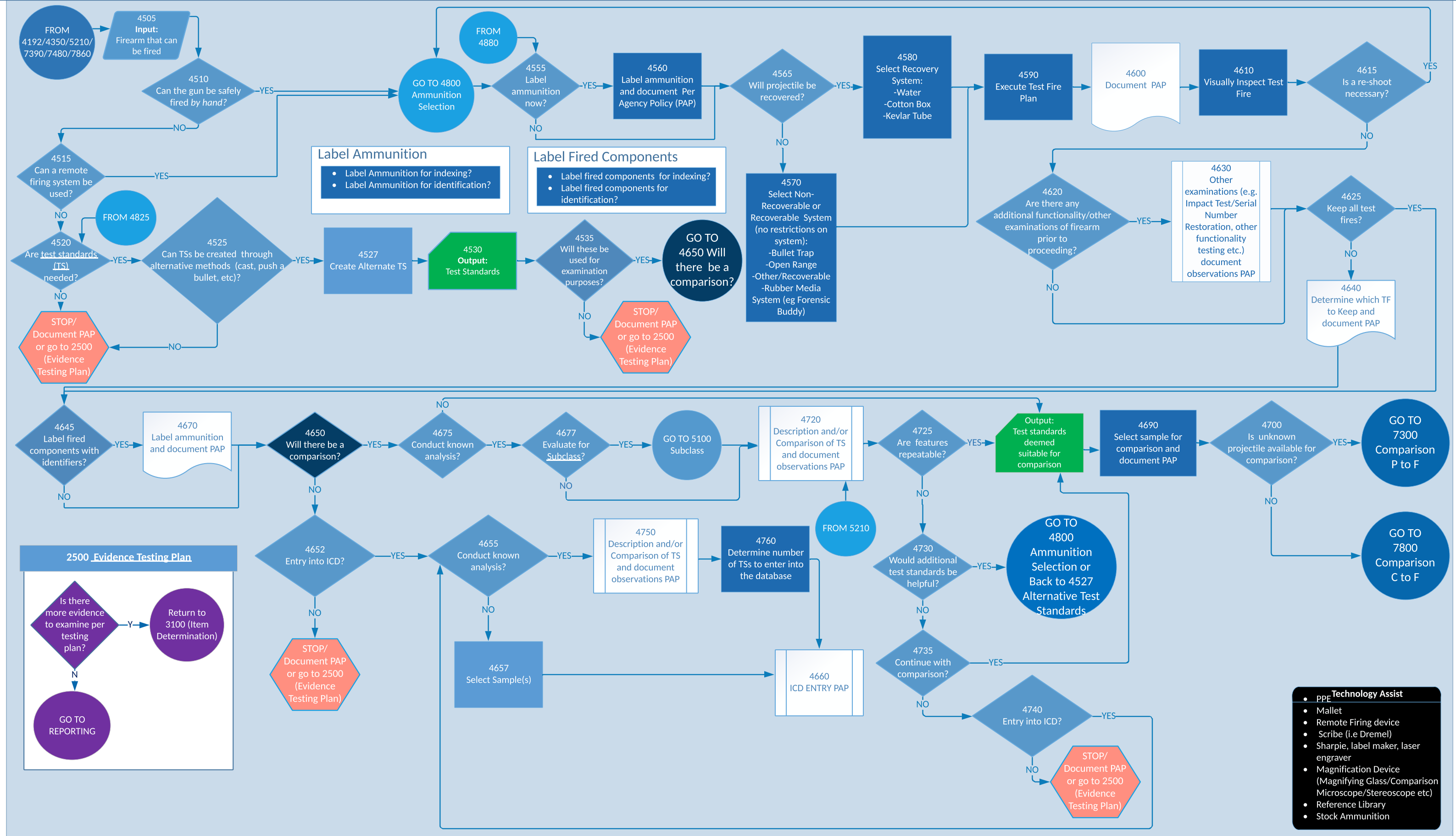
NOTE: Multiple safety and functionality steps are interchangeable. Some are sequential, others are simultaneous, some order is agency specific.

Technology Assist

- Camera
- LIMS
- Balance
- Bore Scope
- Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc
- Flashlight
- Magnet
- Casting Material
- Tool Kit
- Reference Material: Parts and Firearms
- Reference Material: Literature
- General Rifling Characteristics Database

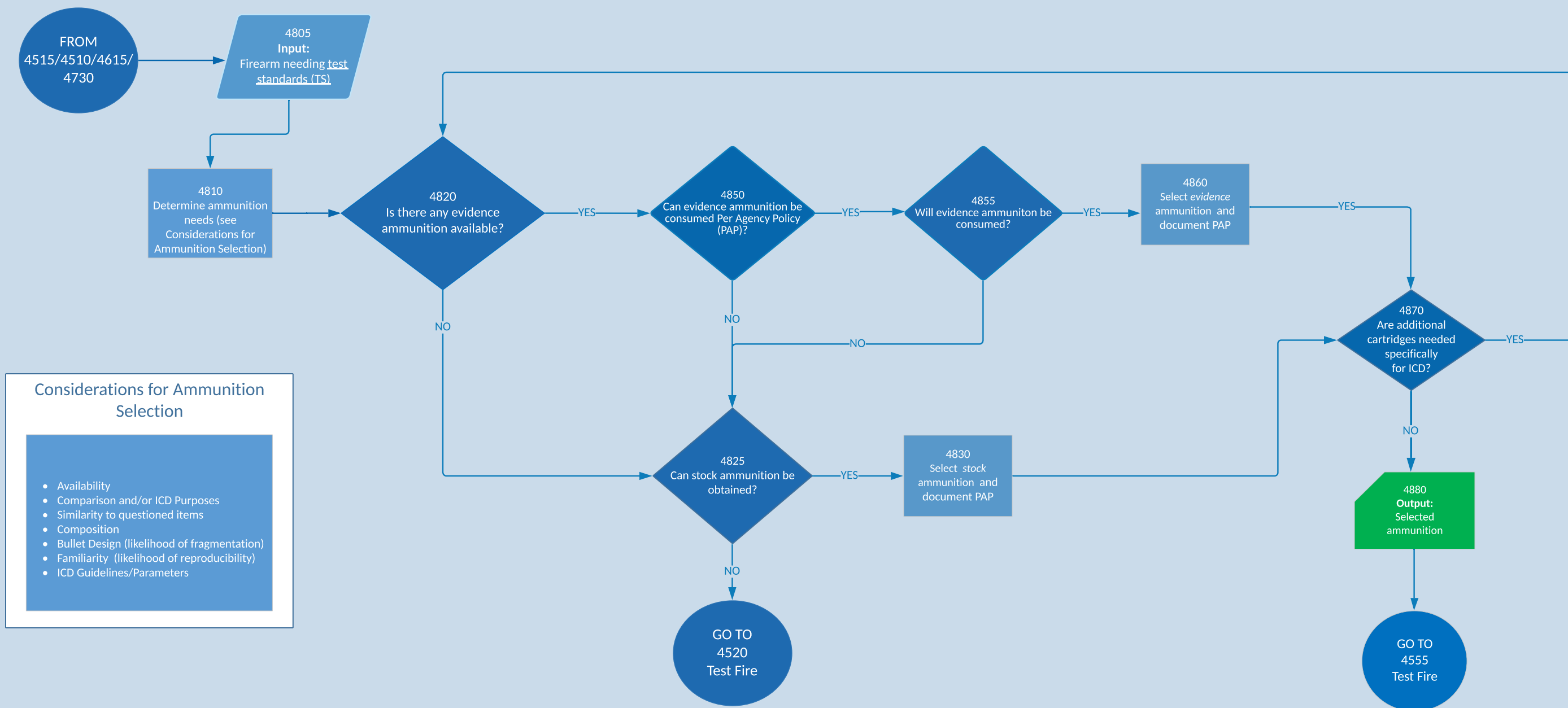
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4500 Test Fire



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4800 Ammunition Selection

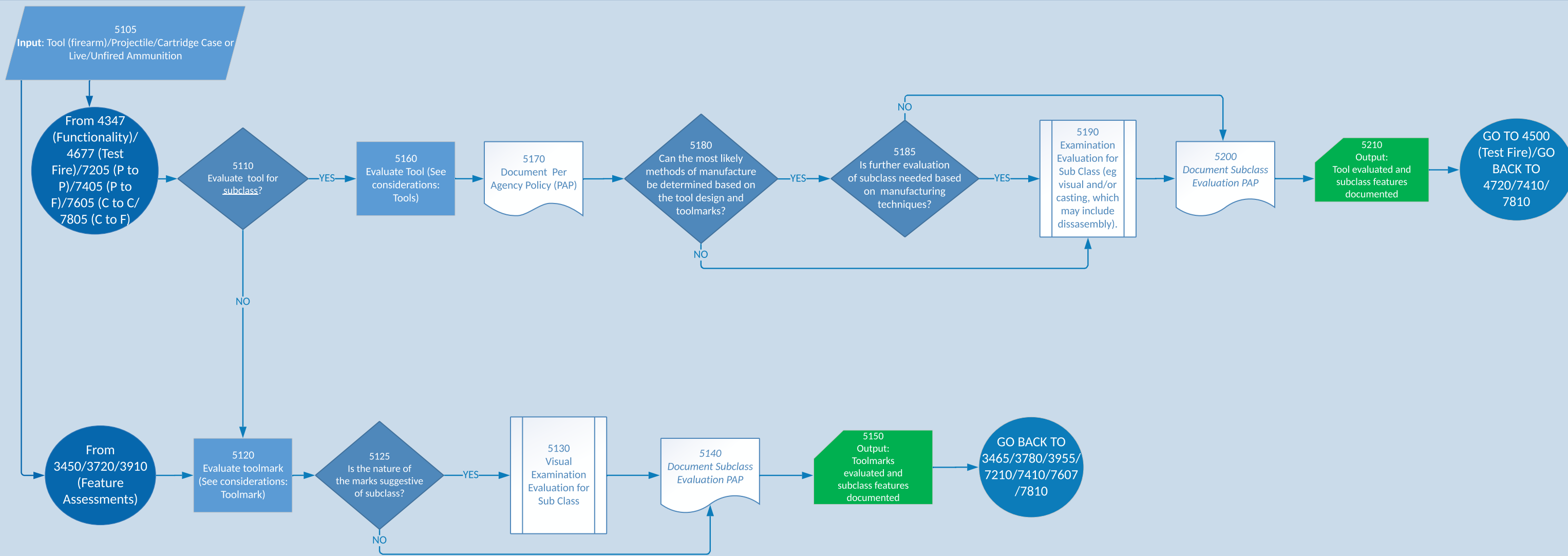


Considerations for Ammunition Selection

- Availability
- Comparison and/or ICD Purposes
- Similarity to questioned items
- Composition
- Bullet Design (likelihood of fragmentation)
- Familiarity (likelihood of reproducibility)
- ICD Guidelines/Parameters

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5100 Subclass Determination



Considerations for Subclass Determination: Toolmarks

- Coarse/Bold Detail
- Continuous markings (eg long continuous toolmarks)
- Gross uniform spacing
- Mold marks
- Similarity of Pattern in other areas
- Symmetry
- How the tool moves against substrate/object

Considerations for Subclass Determination: Tools

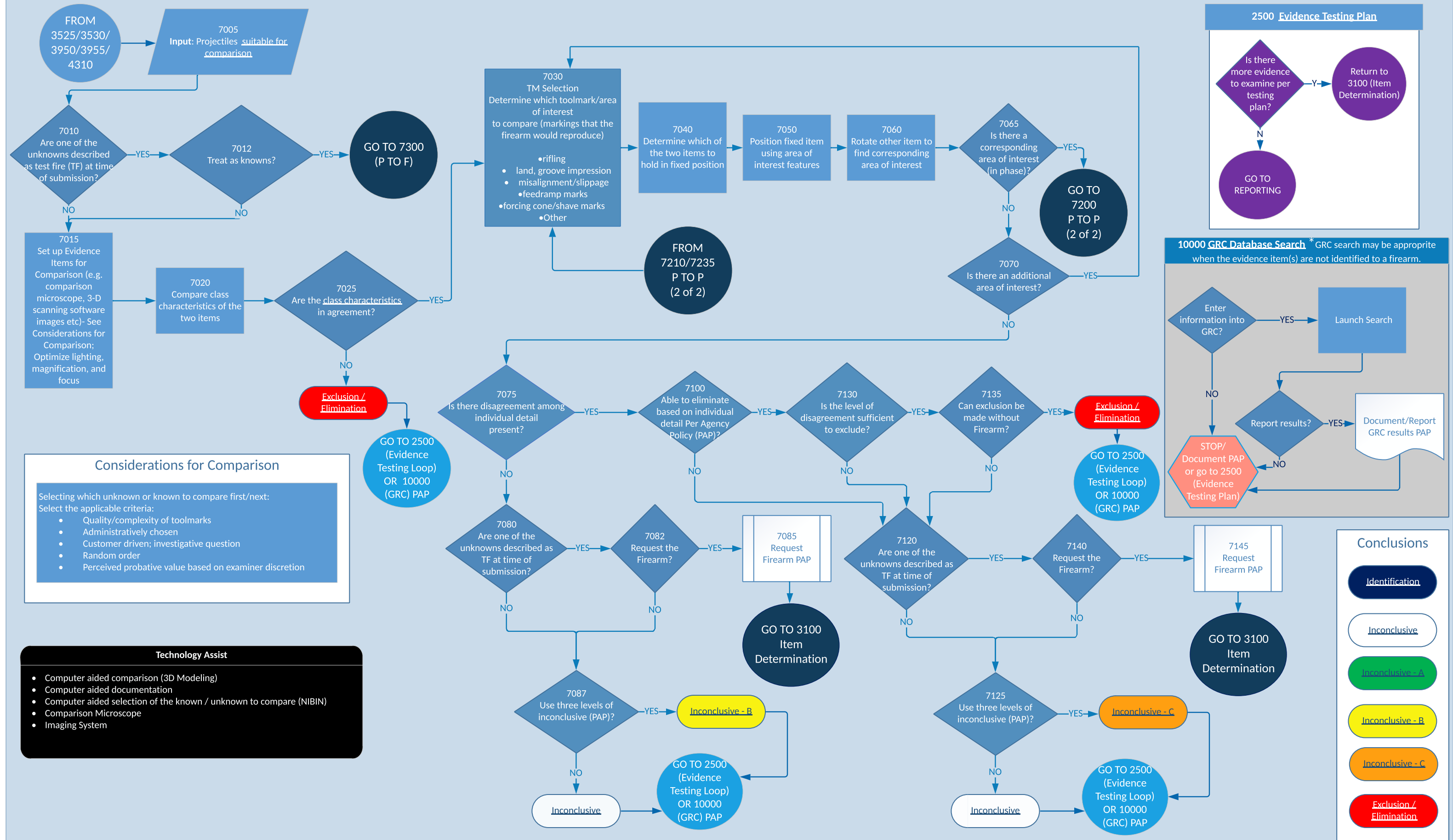
- Most likely manufacturing method based on tool design
- Location of tool surfaces
- Directionality of marks
- Part lines/Mold marks
- Manufacturer literature or reference materials
- How the tool moves against substrate/object

Technology Assist

- Camera
- LIMS
- Balance
- Bore Scope
- Magnification Device (Magnifying Glass/Comparison Microscope/Stereoscope etc)
- Measurement Projection Scope
- Flashlight
- Magnet
- Casting Material
- Tool Kit
- Reference Material: Parts and Firearms
- Reference Material: Literature
- General Rifling Characteristics Database

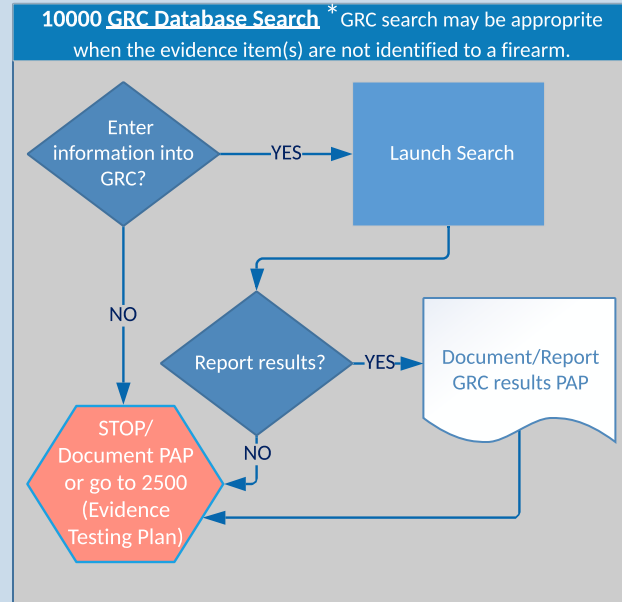
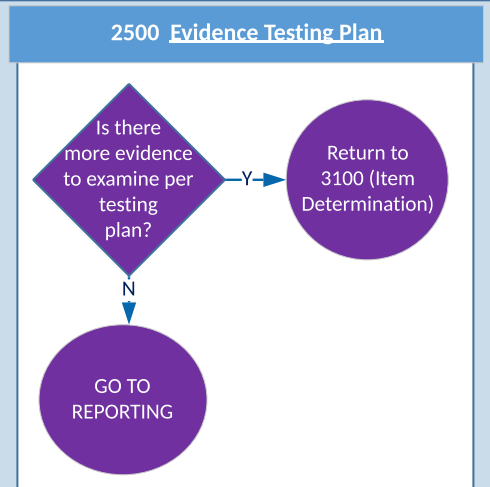
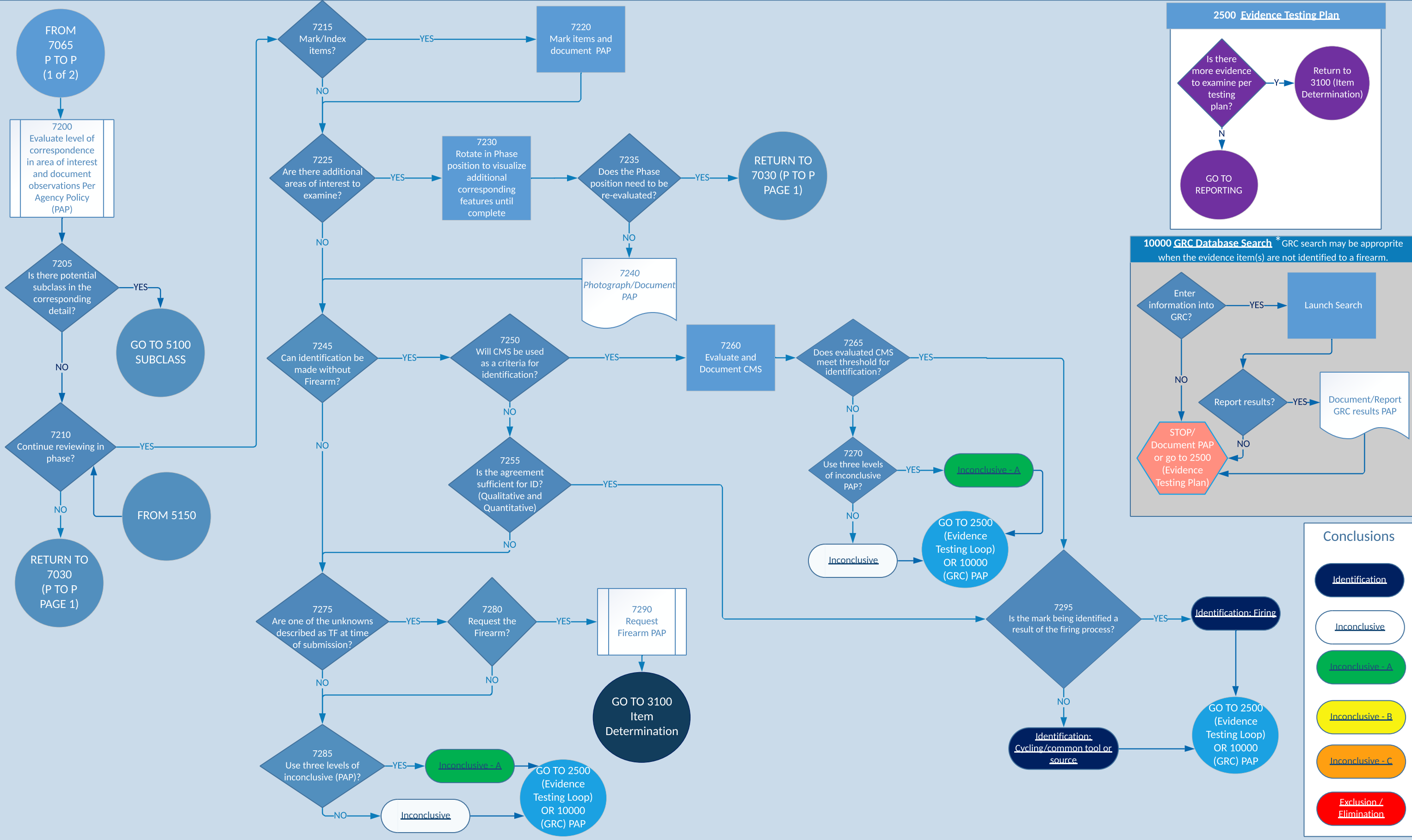
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7000 Comparison: Projectile to Projectile (P to P) 1 of 2



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7200 Comparison: Projectile to Projectile (P to P) 2 of 2

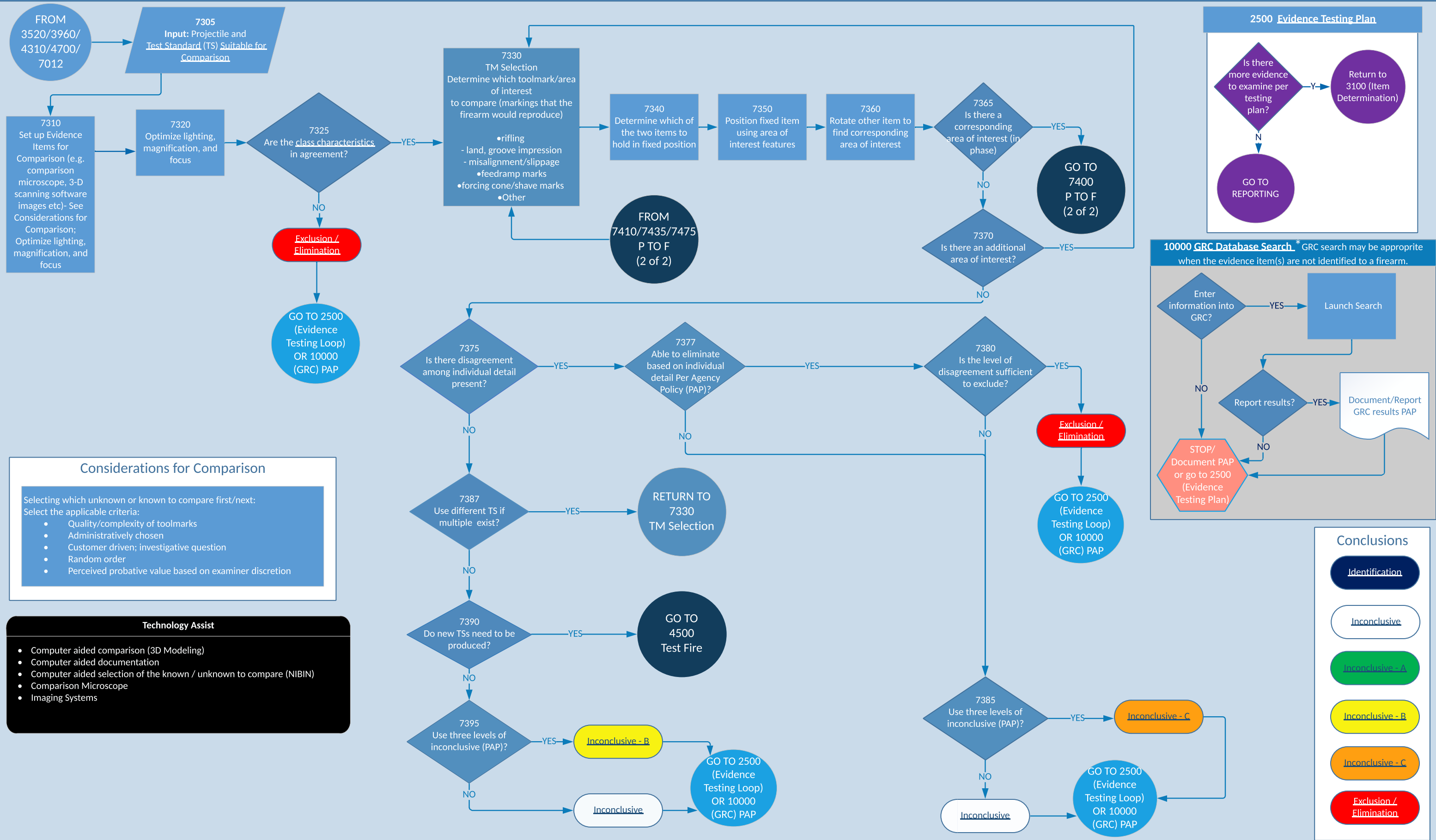


- Conclusions**
- Identification
 - Inconclusive
 - Inconclusive - A
 - Inconclusive - B
 - Inconclusive - C
 - Exclusion / Elimination

This process map provides a visual description and attempts to represent all reasonable variations of casework currently performed by firearm examiners. OSAC and AFTE do not necessarily support or endorse (as best practices) all of the different steps and paths depicted in this process map.

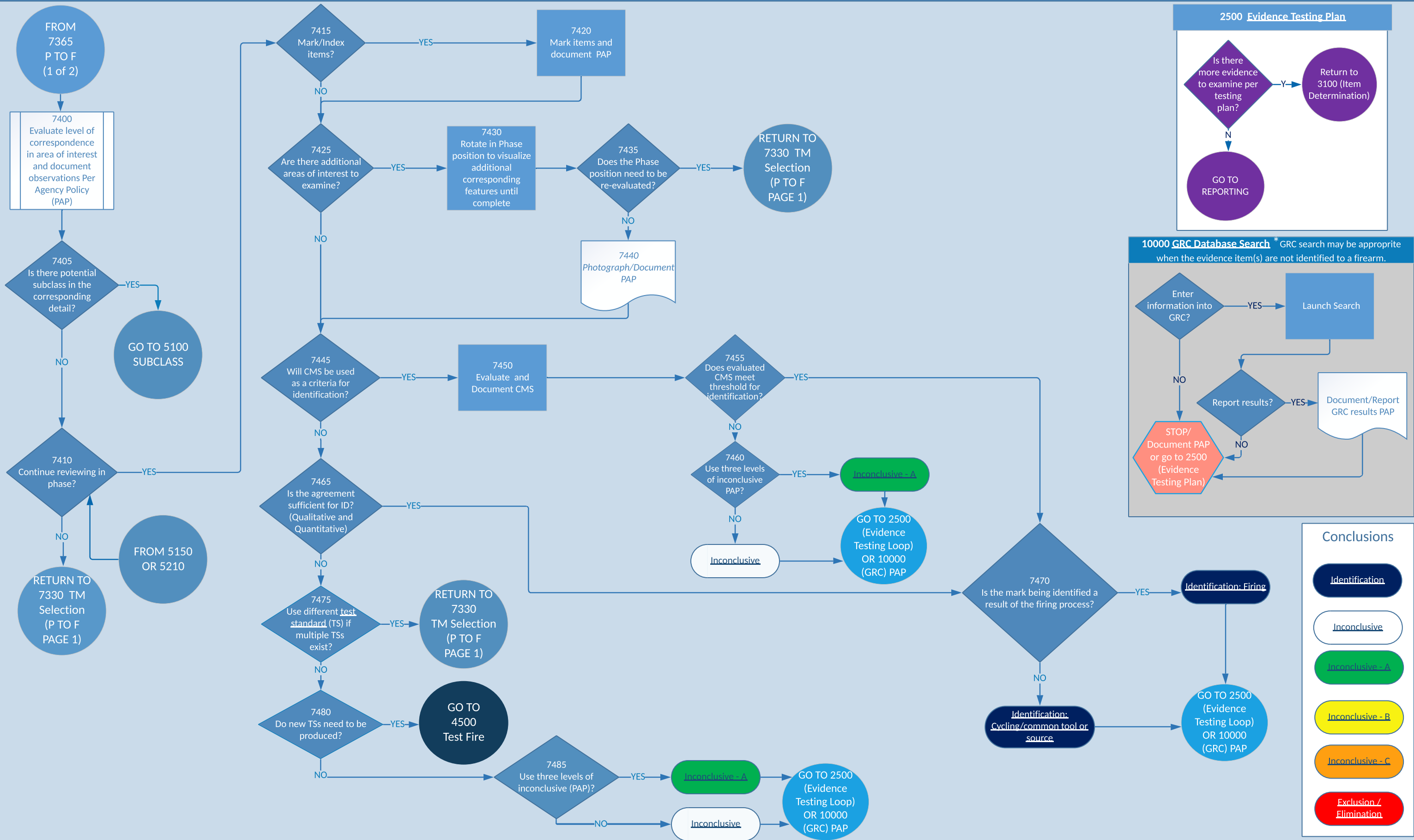
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7300 Comparison: Projectile to Firearm (P to F) 1 of 2



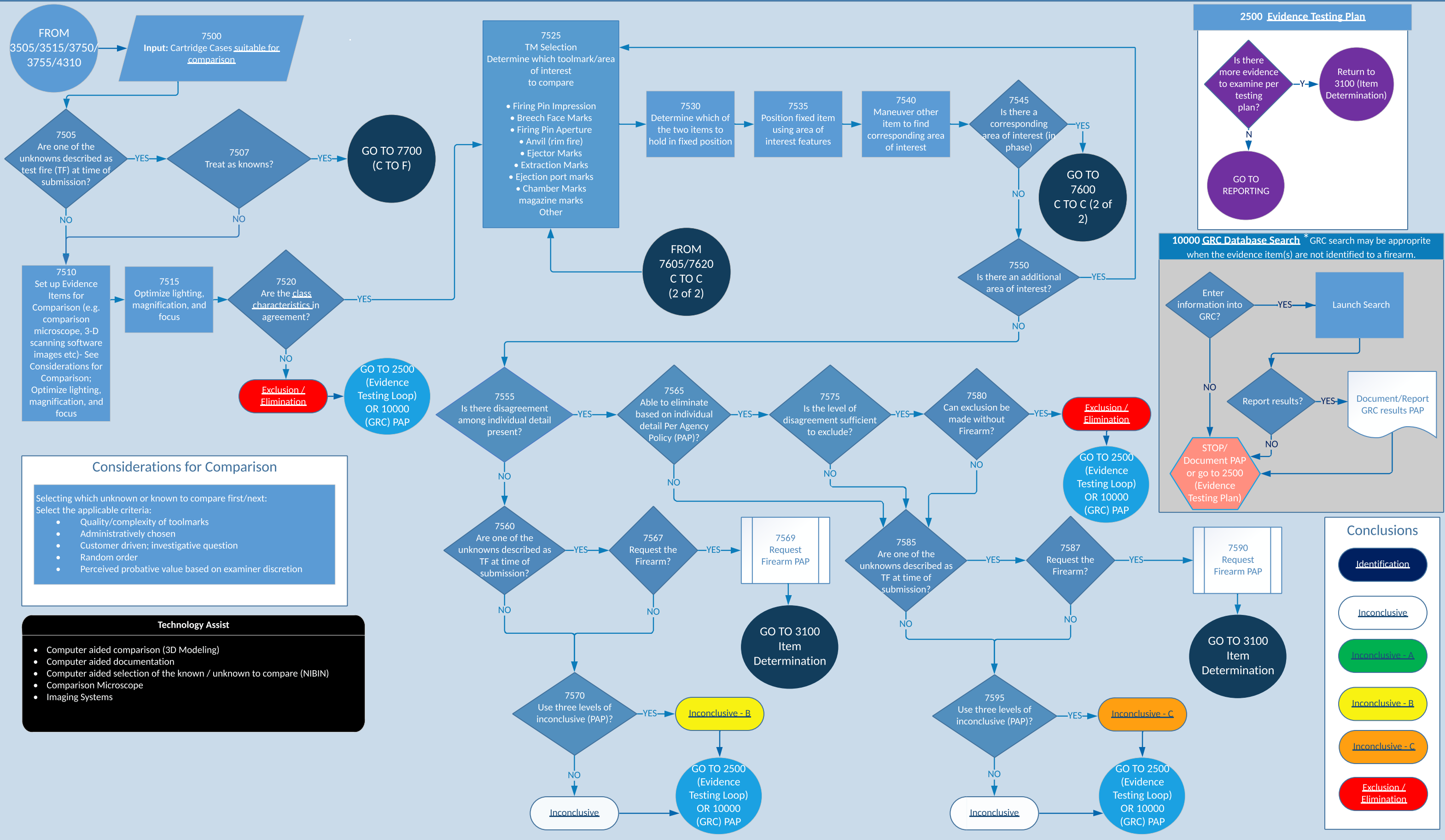
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7400 Comparison: Projectile to Firearm (P to F) 2 of 2



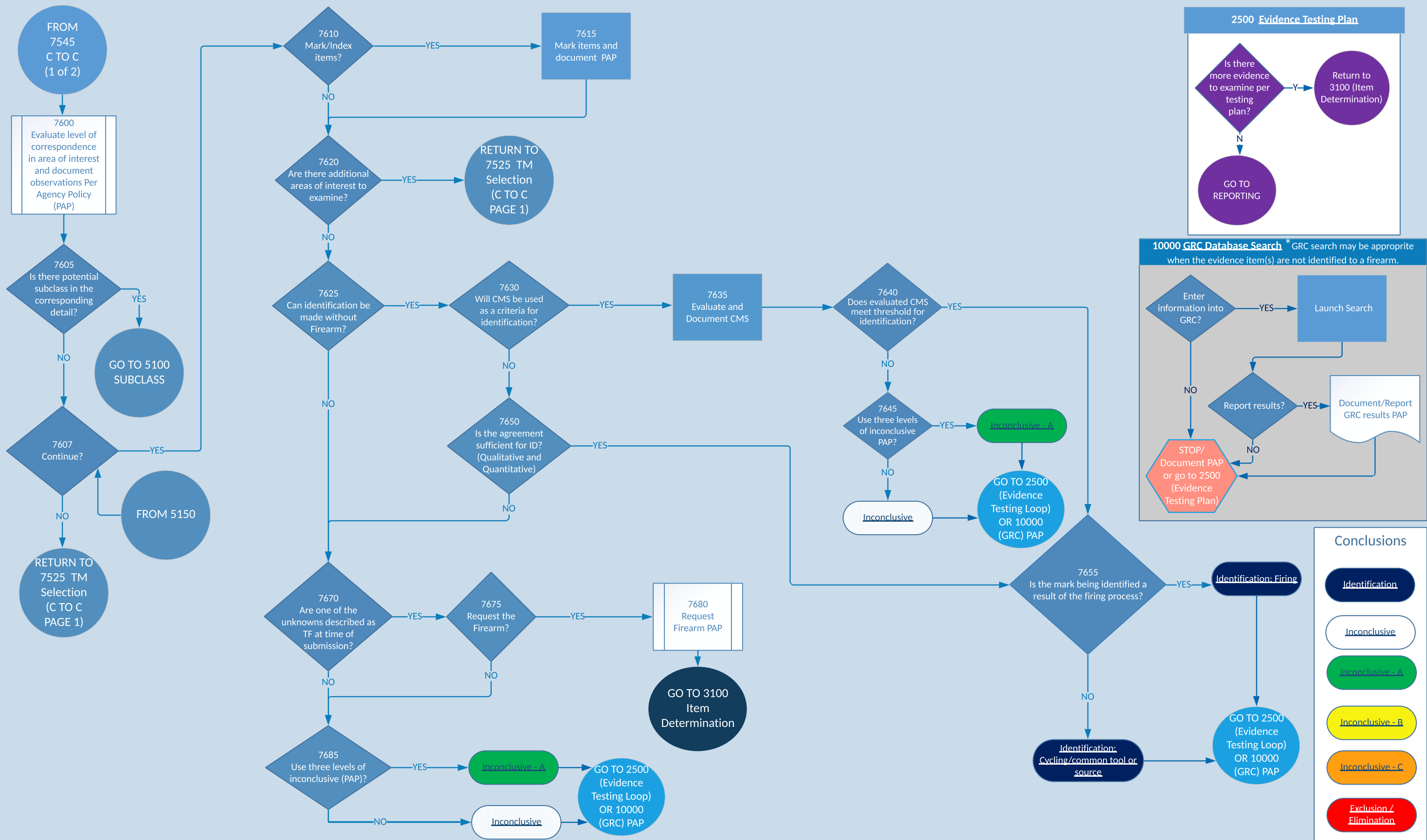
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7500 Comparison: Cartridge Case to Cartridge Case (C to C) 1 of 2



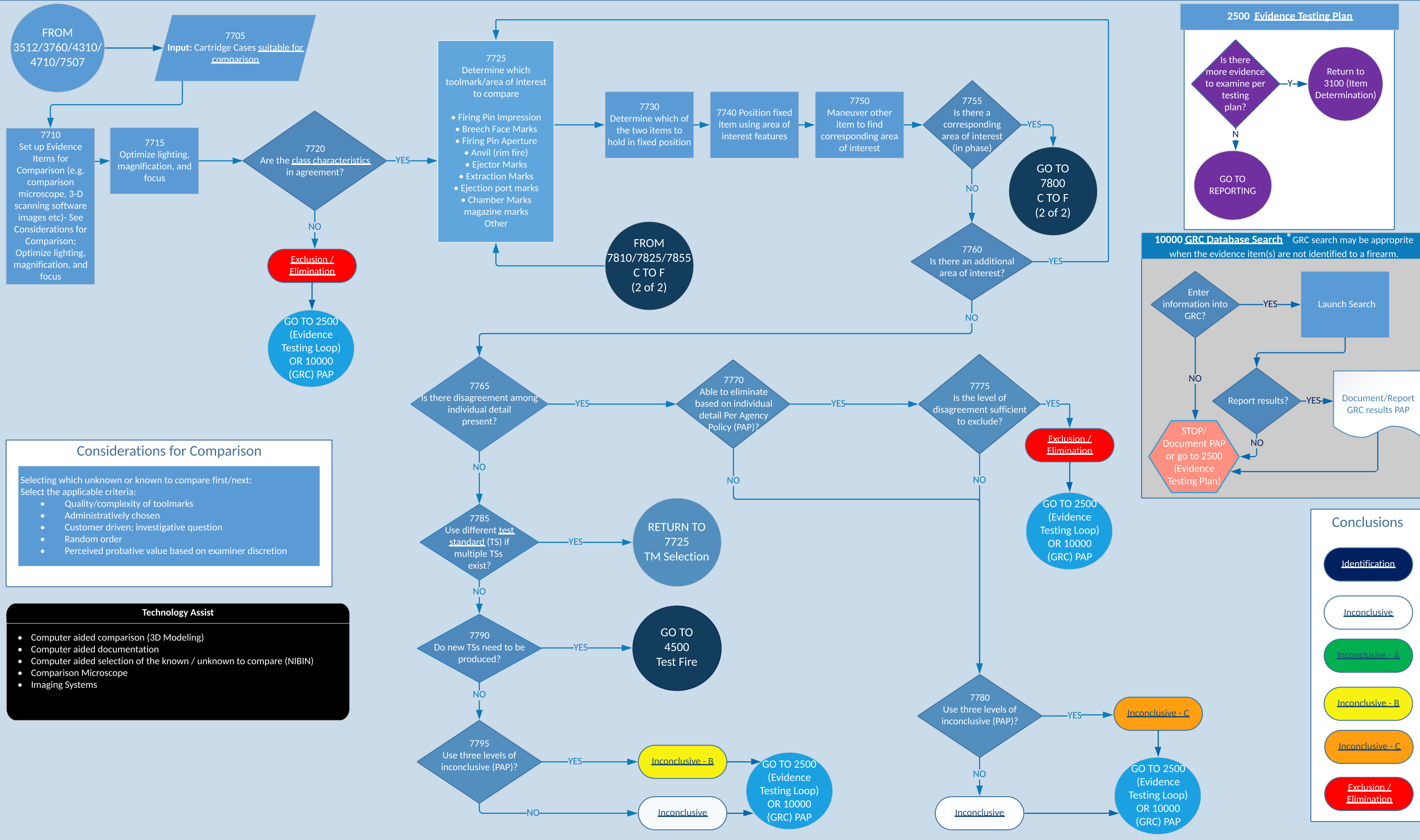
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7600 Comparison: Cartridge Case to Cartridge Case (C to C) 2 of 2



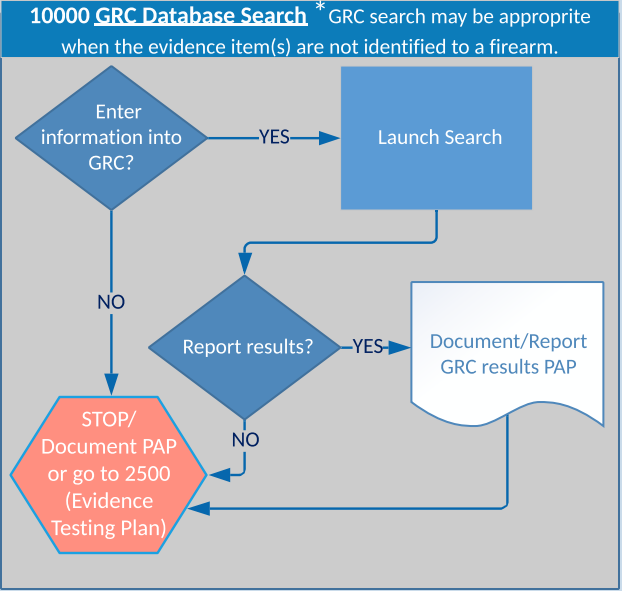
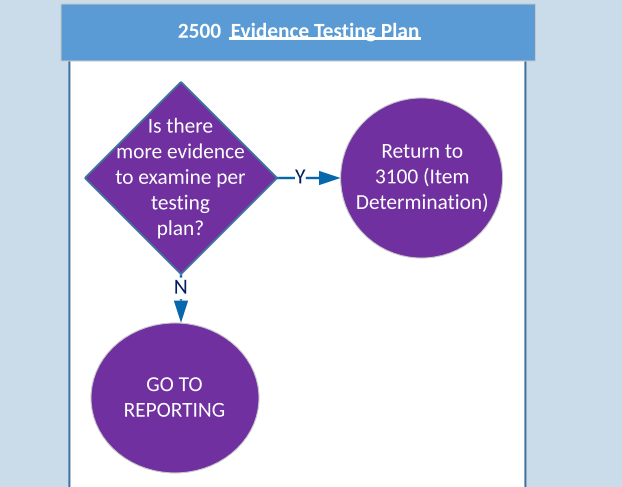
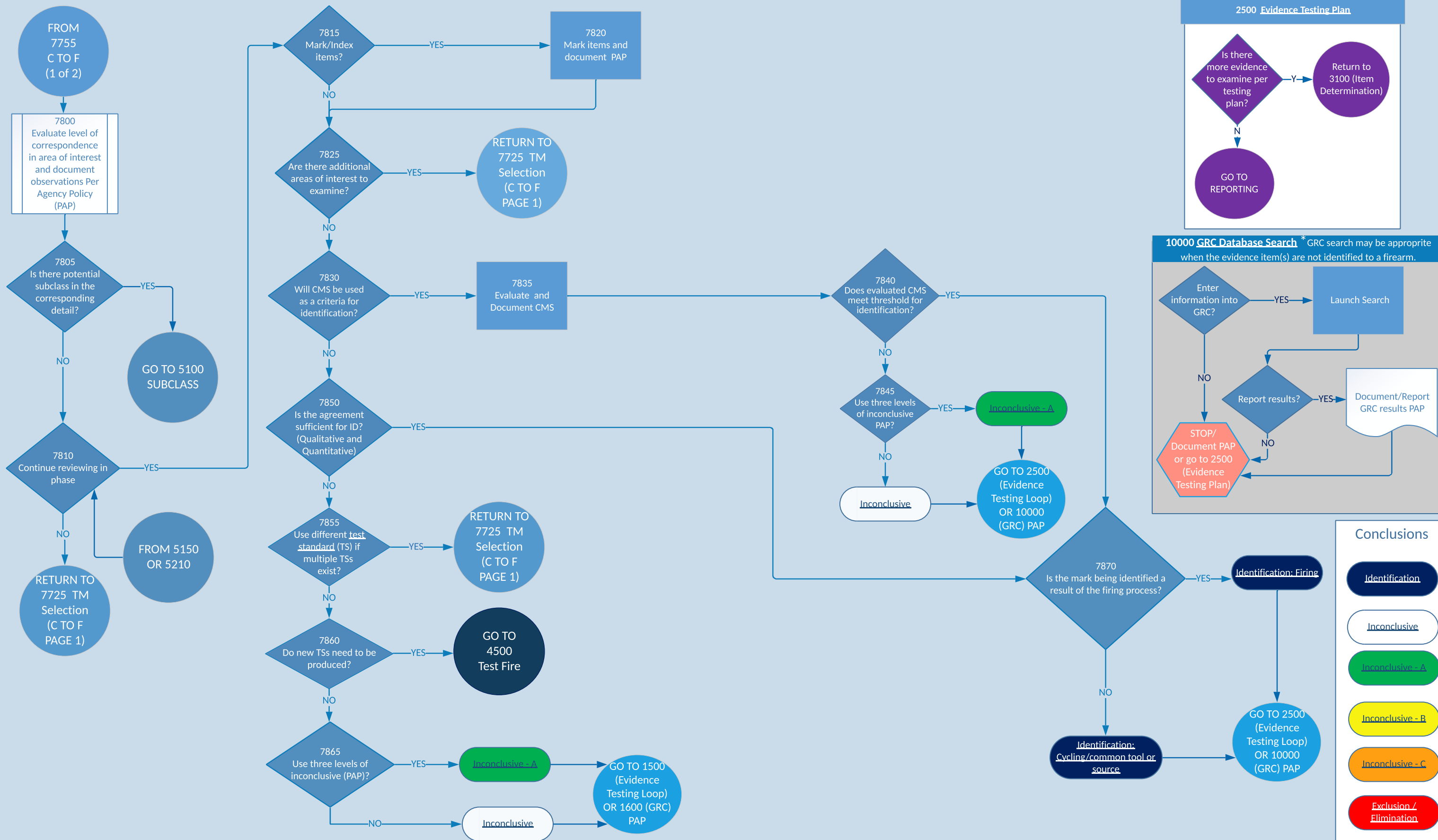
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7700 Comparison: Cartridge Case to Firearm (C to F) 1 of 2



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7800 Comparison: Cartridge Case to Firearm (C to F) 2 of 2



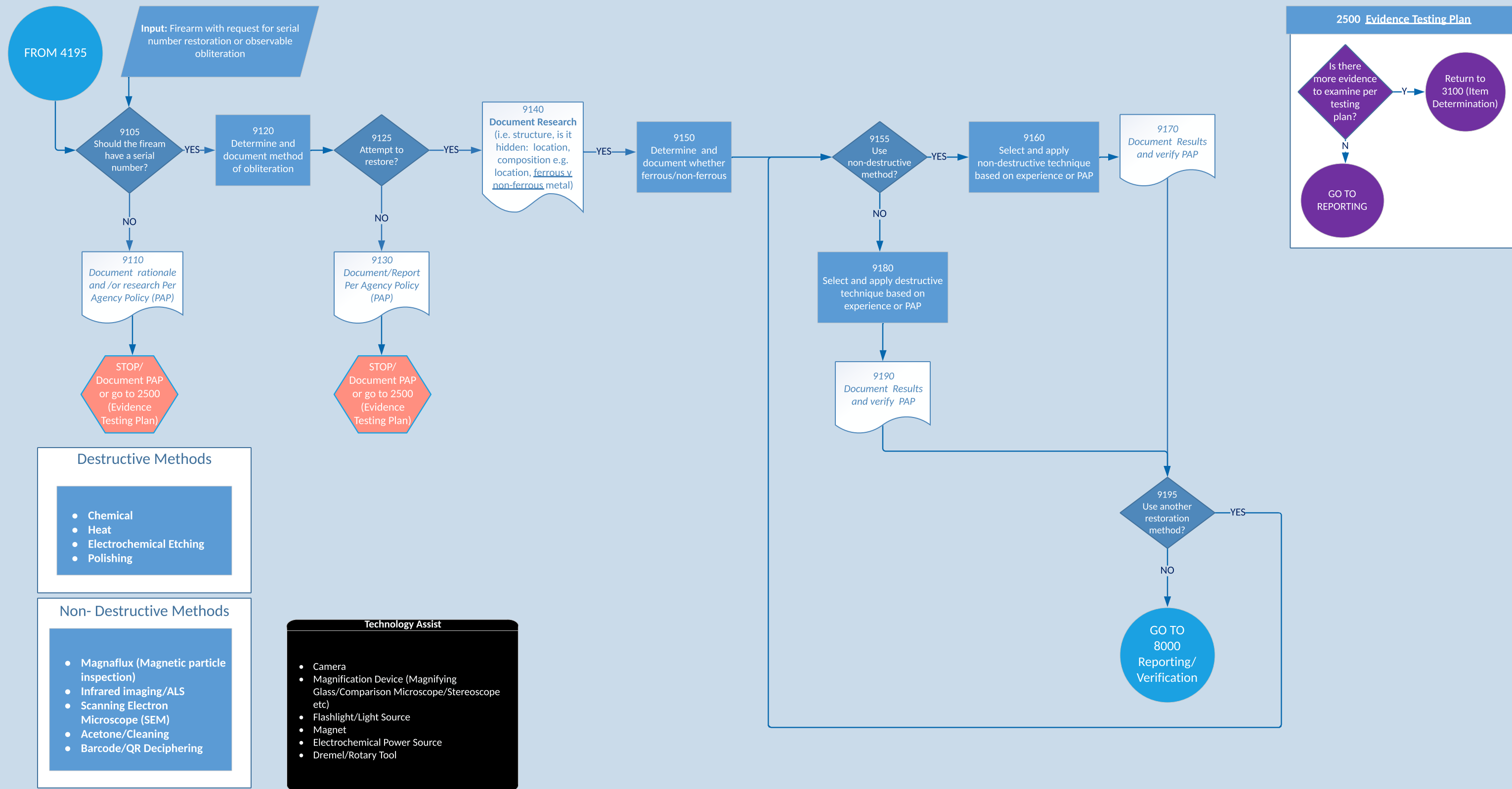
Conclusions

- Identification
- Inconclusive
- Inconclusive - A
- Inconclusive - B
- Inconclusive - C
- Exclusion / Elimination

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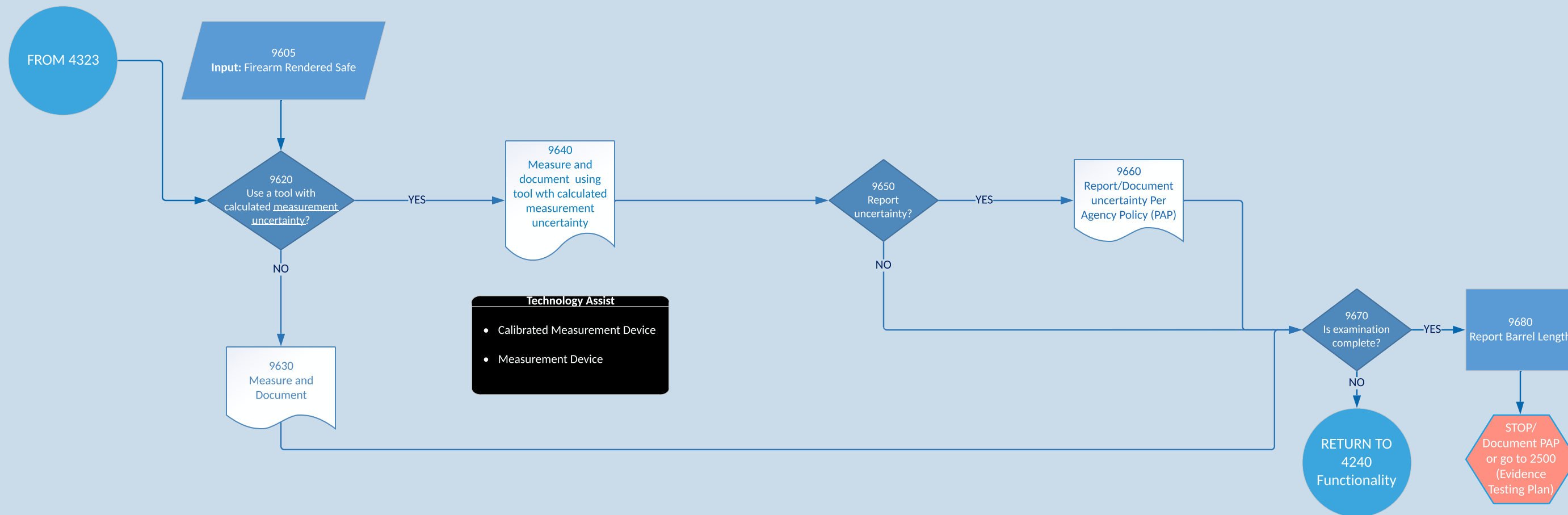
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9100 Serial Number Restoration



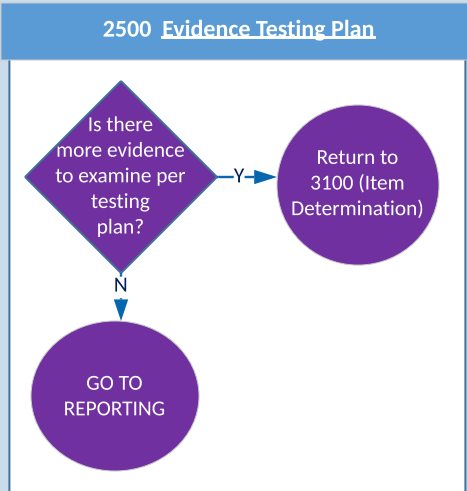
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9600 Barrel Length/Overall Measurement



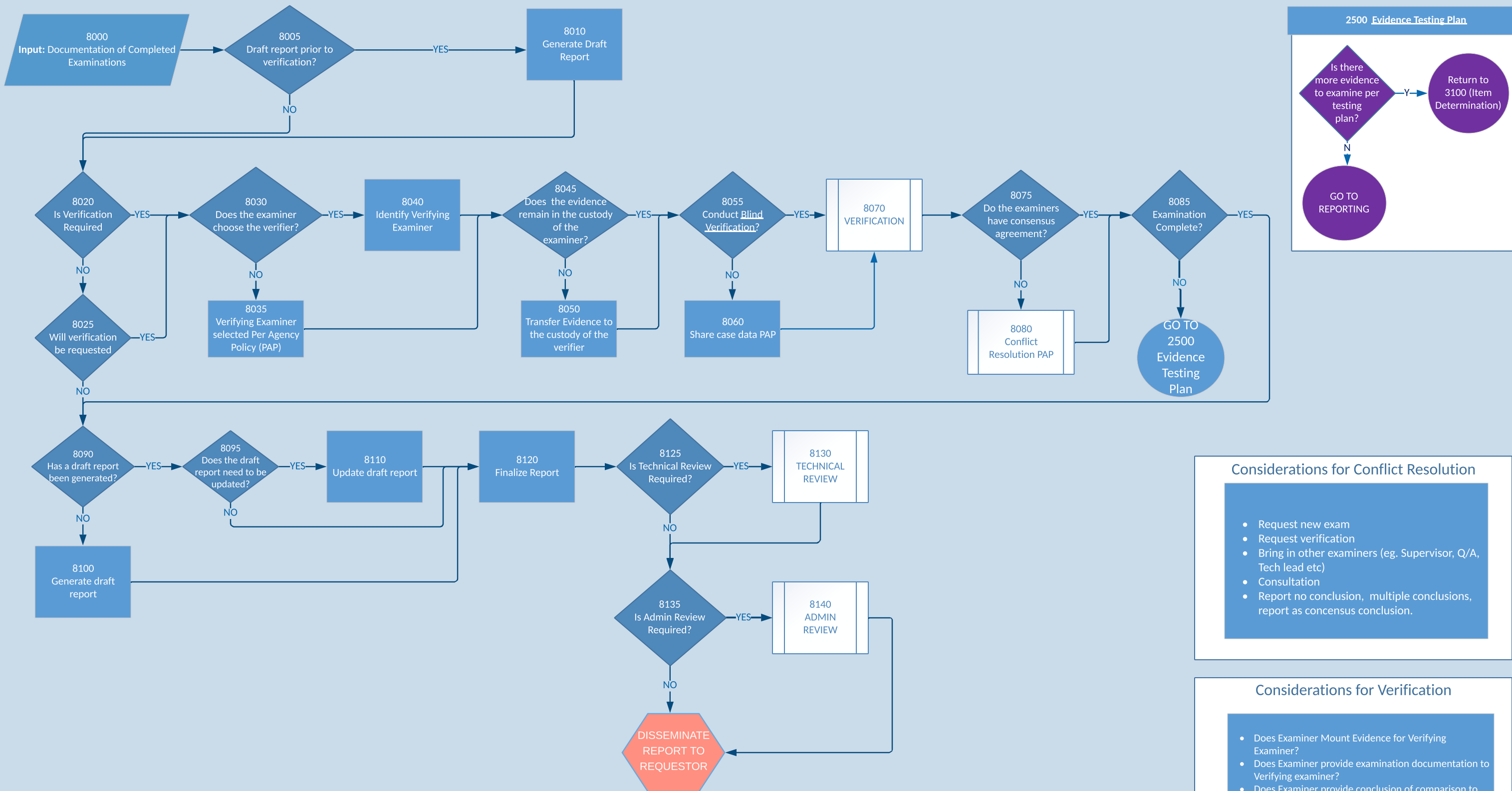
Technology Assist

- Calibrated Measurement Device
- Measurement Device



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8000 - Reporting and Verification



Considerations for Conflict Resolution

- Request new exam
- Request verification
- Bring in other examiners (eg. Supervisor, Q/A, Tech lead etc)
- Consultation
- Report no conclusion, multiple conclusions, report as consensus conclusion.

Considerations for Verification

- Does Examiner Mount Evidence for Verifying Examiner?
- Does Examiner provide examination documentation to Verifying examiner?
- Does Examiner provide conclusion of comparison to Verifying examiner?
- Will case be completely reworked by another examiner or via additional/different methods?

Glossary of Terms and Definitions*

*A brief summary of selected terminology. For the purposes of this document, the AFTE definitions² are used for any terms otherwise not listed here.

Assess Action Type (adopted from AFTE Terminology): Assessment of the working mechanism of a firearm. The combination of the receiver or frame, the breech bolt, and the other parts of the mechanism by which a firearm is loaded, fired, and unloaded. May be broken down into action such as automatic, semiautomatic, bolt action, single action etc.

Blind Verification: The confirmation of an examiner's conclusion by another competent examiner who has no expectation or knowledge of the prior conclusion¹. In some instances, this may lead to an entire re-examination of the case.

Capacity Test: A test to determine the maximum number of cartridges of ammunition a magazine or a magazine and firearm are capable of holding.

Detailed Strip: To disassemble a firearm beyond Field Strip.

Evidence Testing Plan (2500 series): Series of steps placed on the appropriate pages where the user opts to either test additional evidence items in a case or, in the event the examinations are complete, to move on to reporting steps.

Exclusion / Elimination (AFTE Terminology): Significant disagreement of discernible class characteristics and/or individual characteristics.

Ferrous v Non-Ferrous (adopted from AFTE Terminology): Ferrous materials are alloys containing a significant amount of iron. Ferrous metals are magnetic; versus non-ferrous materials where the main component is not iron and is not magnetic.

Field Strip: To disassemble a firearm for cleaning, repair, or transportation.

General Class Characteristics (AFTE Terminology): Measurable features of a specimen which indicate a restricted group source. They result from design factors, and are therefore determined prior to manufacture.

GRC Database: General Rifling Characteristics Database. A database of firearms detailing their general rifling characteristics including, but not limited to; caliber, rifling type, land and groove dimensions, and direction of twist.

GRC Database Search (10000 series): General Rifling Characteristics Database path. Series of steps where the user opts to perform GRC database search during the course of the examination as appropriate, while allowing them to then return and do additional examinations.

Identification (AFTE Terminology): Agreement of all discernible class characteristics and sufficient agreement of a combination of individual characteristics where the extent of agreement exceeds that which can occur in the comparison of toolmarks made by different tools and is consistent with the agreement demonstrated by toolmarks known to have been produced by the same tool.

Impact Test: Testing of a firearm in a controlled setting to determine if discharge may occur as a result of being struck or striking a surface.

Inconclusive: Agreement of all discernible class characteristics. Insufficient agreement and/or disagreement of individual characteristics. Cannot identify or exclude.

Inconclusive - A (AFTE Terminology): Agreement of all discernible class characteristics and some agreement of individual characteristics, but insufficient for an identification.

Inconclusive - B (AFTE Terminology): Agreement of all discernible class characteristics without agreement or disagreement of individual characteristics due to an absence, insufficiency, or lack of reproducibility.

Inconclusive - C (AFTE Terminology): Agreement of all discernible class characteristics and disagreement of individual characteristics, but insufficient for an elimination.

Measurement: In some cases measurements may be taken by linear measurement device for length (e.g. Barrel Length), or may be assessed using a tool to measure weight (e.g. Trigger Pull).

Measurement Uncertainty: Parameter, associated with the result of a measurement, that characterizes the dispersion of the values that could reasonably be attributed to the measurand.³

Safety Mechanisms (AFTE Terminology): A device on a firearm intended to help provide protection against accidental discharge under normal usage when properly engaged.

Subclass Characteristics (AFTE Terminology): Features that may be produced during manufacture that are consistent among items fabricated by the same tool in the same approximate state of wear. These features are not determined prior to manufacture and are more restrictive than class characteristics.

Suitability for Comparison (Suitability Determination): Assessment of whether an item exhibits class and/or individual detail.

Test Standards (TS): Known standards produced by/from a tool/firearm/firearm parts. Can include test fired ammunition components, casts, forced/pushed bullets.

Trigger Pull Measurement (AFTE Terminology): Measurement of the amount of force which must be applied to the trigger of a firearm to cause sear release. It is measured by hanging weights or an instrument touching the trigger at a point where the trigger finger would normally rest. The force applied during measurement is approximately parallel to the bore axis.

Trigger Puller : An instrument used to accurately measure the trigger pull of a firearm. Examples include standard weights, spring gauges, and mechanical/digital devices. Also known as a trigger tester.

Abbreviations:

PAP: Per Agency Policy

ICD: Individual Characteristic Database

¹The *Fingerprint Sourcebook*. Washington, DC: U.S. Dept. of Justice, Office of Justice Programs, National Institute of Justice, 2011.

²AFTE Glossary: <https://afte.org/resources/afte-glossary>

³<https://www.nist.gov/itl/sed/topic-areas/measurement-uncertainty>