

GOOSE Message Size Calculation

Edit Items in **Red** to adjust size based on configuration changes.

14	Ethernet Header	
4	802.1P/Q Tag	
2	APPID: 2 bytes	
2	PDU Length: Integer - 2 bytes	
4	Reserved - 4 bytes	
	Control Block Reference	
14	IED Name	IED name is user configured in Architect (limited to a max of 29 characters)
14	Control Block Name	Called Message Name in Architect (limited to 16 characters)
12	LD instance (3 char) and /LLN0\$GO\$ (9 char)	
42	2 ASN.1 encoding	
	Time Allowed to Live	
2	Integer: Minimum of 1 byte, but more typical 2 bytes	
4	2 ASN.1 encoding	
	Data Set Reference	
14	IED Name	Used as defined above
14	Data Set Name	Defined in Architect (limited to 16 characters)
9	LD instance (3 char) and /LLN0\$ (6 char)	
39	2 ASN.1 encoding	
	GOOSE ID	
14	String	GOOSE ID is configured in Architect (limited to 64 characters)
16	2 ASN.1 encoding	
	Event Time Stamp (Message time stamp)	
8	UTC time	
10	2 ASN.1 encoding	
	State Number	
2	Integer: Min 1 byte, typical 2	
4	2 ASN.1 encoding	
	Sequence Number	
2	Integer: Min 1 byte, typical 2	
4	2 ASN.1 encoding	
	Test	

	1 Boolean: 1 byte	
3	2 ASN.1 encoding	
Configuration Revision		
	1 Integer: Min 1 byte	
3	2 ASN.1 encoding	
Needs Commissioning		
	1 Boolean: 1 byte	
3	2 ASN.1 encoding	
Num Data Set Entries		
	1 Integer: Min 1 byte	
3	2 ASN.1 encoding	
Data Set is configured in Architect (any allowed data)		
Data Set is configured in Architect (any allowed data)		
Data		
357	119	3 Boolean: 1 byte + 2 (ASN.1)
0	0	4 Quality: 13 bits (2 bytes) + 2 (ASN.1)
0	0	6 Analog: 4 bytes + 2 (ASN.1)
0	0	4 Quality: 13 bits (2 bytes) + 2 (ASN.1)
357 Total for data and encoding		

496 Total GOOSE size (Payload of Ethernet Frame)
 4 Ethernet Frame CRC

518 Total GOOSE msg size (bytes)

4144 Total GOOSE msg size (bits)

1000 (ms) message repetition time
0.004144 Mbs Bandwidth needed for message

Network IP Addresses

Table iii. Instructor Station Addresses

Station	Device	IP Address	Subnet Mask	Default Gateway
Control	SEL-3620	Eth 1: 10.10.10.254 Eth 2: 172.16.254.1 Eth F: 192.168.254.1	Eth 1: 255.255.255.0 Eth 2: 255.255.255.0 Eth F: 255.255.255.0	None
Control	SEL-3351	172.16.254.2	255.255.255.0	172.16.254.1
Control	Instructor laptop	172.16.254.3	255.255.255.0	172.16.254.1
Control	SEL-2032	172.16.254.4	255.255.255.0	172.16.254.1
Control	SEL-3530	172.16.254.5	255.255.255.0	172.16.254.1

Table iv. Student Station Addresses

Station	Device	IP Address	Subnet Mask	Default Gateway
Station X	SEL-3620	Eth 1: 10.10.10.X Eth 2: 172.16.X.1 Eth F: 192.168.X.1	Eth 1: 255.255.255.0 Eth 2: 255.255.255.0 Eth F: 255.255.255.0	None
Station X	SEL-2032	172.16.X.2	255.255.255.0	172.16.X.1
Station X	Student laptop	192.168.X.2	255.255.255.0	192.168.X.1

NOTE: Replace X with your station number (1–16).

Table v. APP 3620 Station X Connections

SEL-3620	SEL-2032	SEL-2411	Laptop	SEL-2730M	Cable
Eth 1				Ethernet Port 9 to 24	C627
Eth 2	Ethernet Port 17A				C627
Eth F			Ethernet		C627
COM 02		Serial Port 3			C273A
	Serial Port 1	Serial Port F			C627

NOTE: You can use a C273A cable if needed for an SEL-3620-serial-to-laptop-serial connection.

IEC 61850 Design and Configuration Best Practices

This will be a in depth discussion of the Design process and considerations for an IEC 61850 substation communications system. The configuration specifics to address the design and communications will be address in detail.

Agenda

1. Overview

(This section address the MMS messages used to communicate for Client/Server exchanges. Each item will be described and discussed specific to the implementation in the relay interfaces. Additional topics include the internal data management in the relay sever implementations and the impact on data exchanges and data updates specific to IEC 61850 communications.)

a. MMS Services

i. Initiate

ii.Abort

iii.Reporting

1. Data change

2. Period

3. GI

4. Optfields

iv.GOOSE

1. Data change (data set)

2. Boolean / Analog Data

v.MMS Inactivity Timeout

b. Clients

i. Reports and configuration

1. TrgOpts

2. OptFields

c. Relay Data Exchange – Process to Protocol

i. Update period (Data Store)

ii.Handling SER data

1. Timestamps

a. Who

b. What

c. Where

iii.Handling GOOSE data

iv. Analogs in GOOSE

2. Configuration Considerations

(This section focuses on the available configuration options in the relay 61850 interfaces. Optimization and communications impacts will be discussed specific to choices made during the configuration process.)

a. Reports

- i. Buffered
- ii. Unbuffered
- iii. Data sets
- iv. Client Update method

b. GOOSE

- i. Data sets
- ii. Application considerations

c. Relay settings

d. Ethernet Settings

- i. TCP/IP
- ii. GOOSE

3. Network Design and Test

(Network configuration and architecture are a major impact to 61850 communications. This section discusses the different methods available and identifies the impacts to designs, implementations, configuration, and messaging.)

a. Failover Mode

b. Redundancy

- i. RSTP
- ii. PRP
- iii. HSR (Never)
- iv. SDN??

c. Traffic Management

- i. Multicast Address
- ii. VLAN

iii. Bandwidth Limiting

Table 1 presents the system integration and automation functions required in a substation. Comparison is made of substation controller devices often used in substation automation and the functions that each device commonly performs.

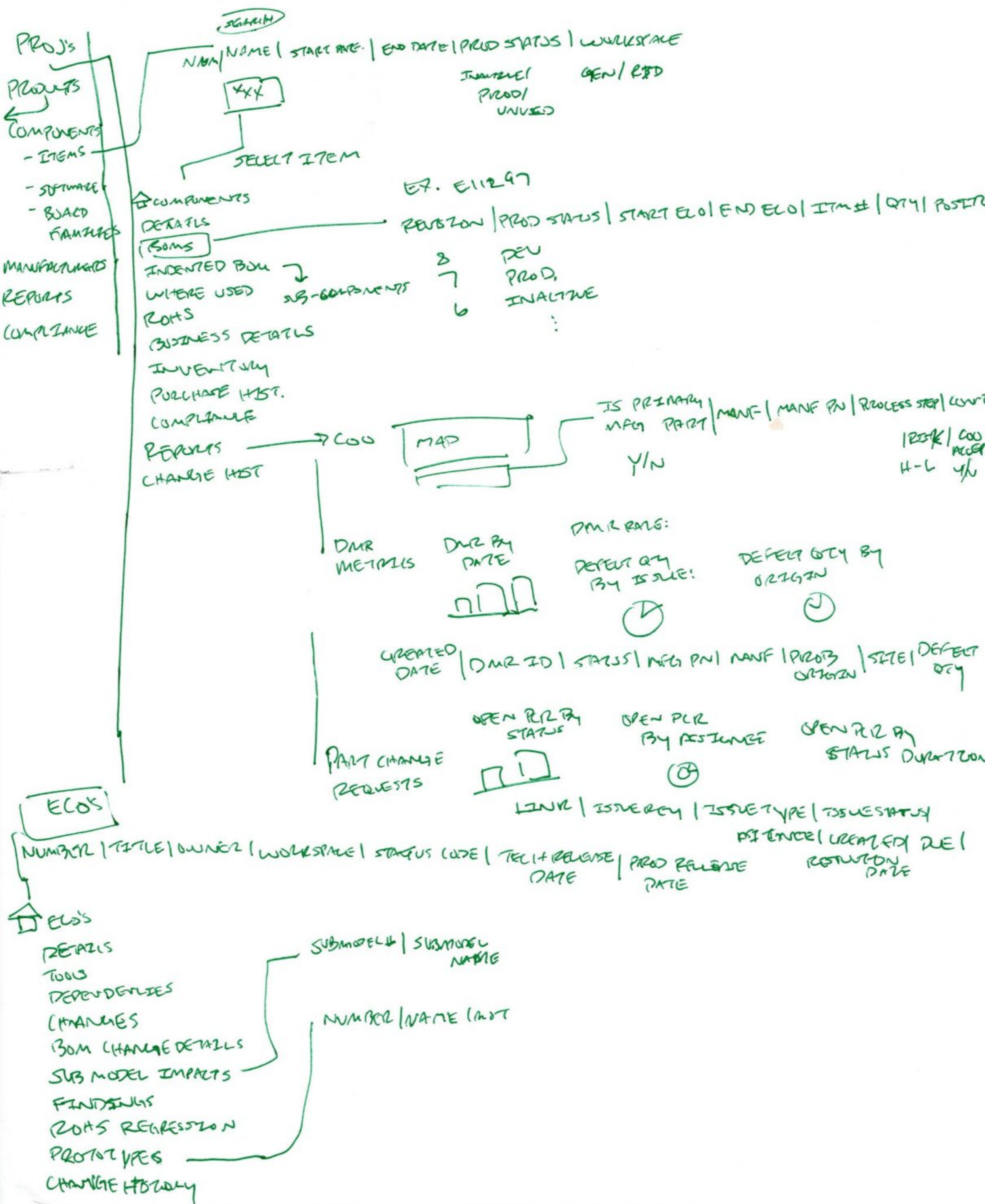
Table 1: Substation Automation Device Comparison

	Communications Processor	RTU	Bay Module	PLC	PC	Port Switch	Satellite Clock
Client/Server for Dynamic Data	✓	✓	✓	✓	✓		
Client/Server for Archived Data (File Transfer to IEDs)	✓				✓		
Data Concentrator	✓	✓	✓	✓	✓		
Message Broker	✓						
Programmable Logic Platform	✓	✓	✓	✓	✓		
Protocol Gateway	✓	✓	✓	✓	✓		
Router	✓				✓		
Dial-Out	✓				✓		
Communication Switch (Virtual Terminal and File Transfer to IEDs)	✓				✓	✓	
Time Synchronization Broadcast < 10 milliseconds accuracy	✓						✓
Local I/O	✓	✓	✓	✓			
Emulate Protocol Messaging	✓				✓		
Eavesdrop Communications	✓						
Autoconfiguration	✓						
Device-Level SER	✓	✓	✓	✓			
Station-Level SER	✓						
Tier-to-Tier	✓			✓	✓		
Peer-to-Peer	✓			✓	✓		
Substation-Hardened Design	✓					✓	✓

Client/Server for Dynamic Data

The communications industry uses the term client/server for a device that acts as a master, or client, retrieving data from some devices and then acts as a slave, or server, sending this data to other devices. The client/server for dynamic data collects and forwards data frequently based on the master poll rate or by exception. These data include protection data, metering data, automation data, control data, and supervisory data.

BP PDM



Phases

Stages

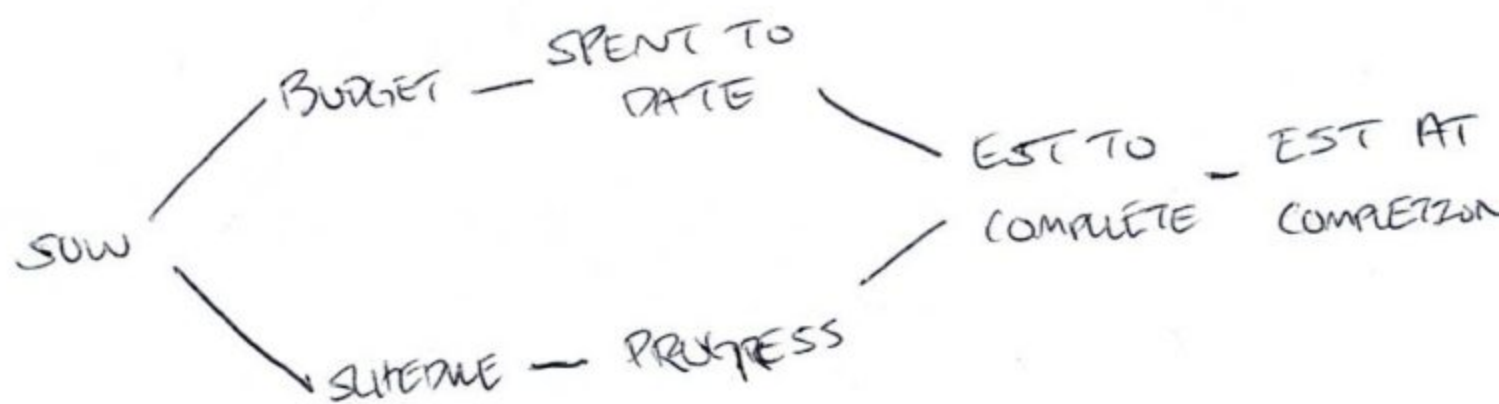
Product | Contact | Rate | Prod Name

- Inputs
- Outputs
- Testimonials
- Summary Tests
- Certifications
- Q&D Resources
- Subscribers
- Sales Items
- Illustrations

COST CONTROL

• BUDGET MGMT

- SOW
- WBS
- DELIVERABLES
- MILESTONES



• RISK + CONTINGENCY MGMT

- LIST HIGH IMPACT & HIGH PROBABILITY RISKS
- DETERMINE HIGHEST RISK

• CHANGE MGMT

- CHANGE VS NOT A CHANGE

• EARNED VALUE MGMT / PERFORMANCE MGMT

- EVALUATING S CURVES

• EAC MGMT

• CONTROLLING COST

- OBSERVATIONS + FLAGGING ON COST SUMMARY REPORT

• RESOURCE MGMT FOR COST & SCHEDULE

PLANNING + SCHEDULING

• PLANNING

• SCHEDULE DEVELOPMENT

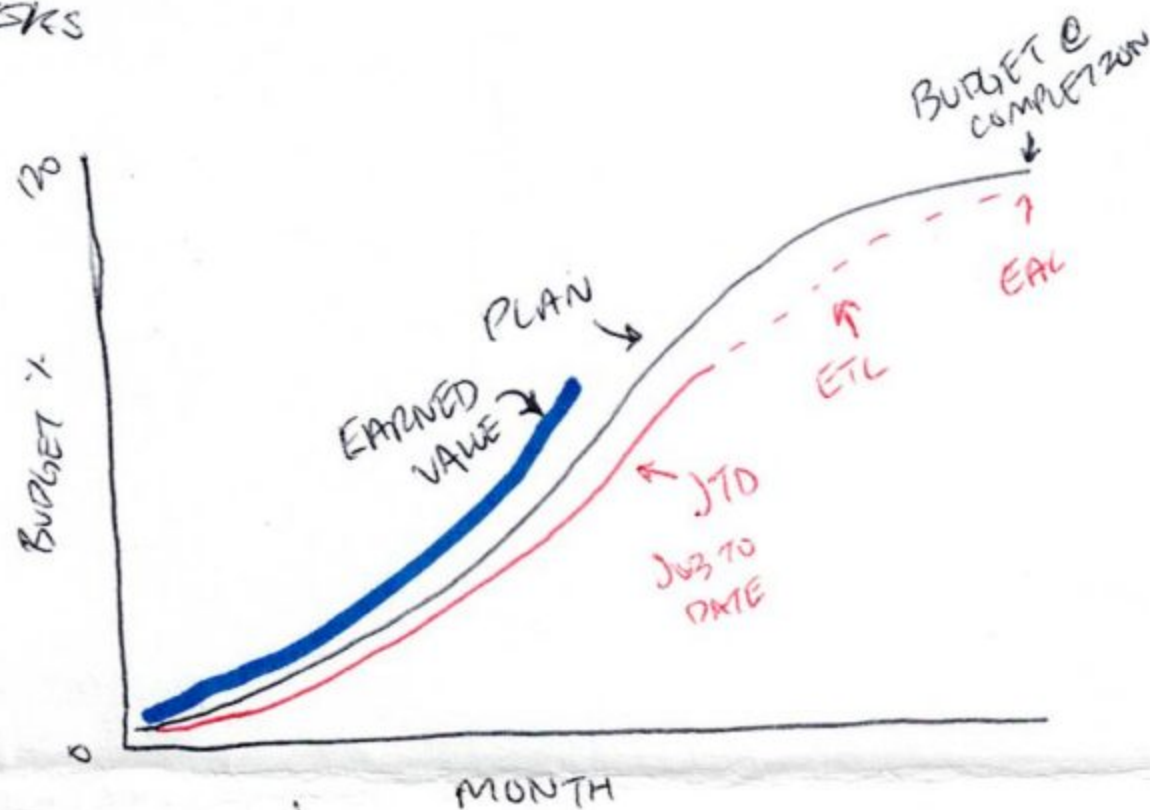
- ACTIVITY TYPE, DURATION, RELATIONSHIP
- CRITICAL PATH

• SCHEDULE MGMT

- RESOURCE & COST LOADING

PROJECT CONTROLS

- COMBINED PRACTICE



PLAN → TRACK → REPORT → ANALYZE → FORECAST → ADJ

Principles behind the Agile Manifesto

We follow these principles:

Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.

Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.

Deliver working software frequently, from a couple of weeks to a couple of months, with a preference to the shorter timescale.

Business people and developers must work together daily throughout the project.

Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.

The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.

Working software is the primary measure of progress.

Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.

Continuous attention to technical excellence and good design enhances agility.

Simplicity--the art of maximizing the amount of work not done--is essential.

The best architectures, requirements, and designs emerge from self-organizing teams.

At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Note:

This document was migrated from LotusNotes, causing the Revision Number to restart at Rev 1. Prior revisions of this document were maintained in LotusNotes. The LotusNotes revision history is included at the end of this document.

Purpose and Scope

Ensure SEL designs and delivers quality automation solutions for our customers. Maintain consistent work flow among automation systems and services.

This applies to all SEL projects requiring automation engineering. This includes communication processor (RTAC) settings, HMIs, network design, and the engineering of automation system design. This document does not cover SPS projects, i.e., [REDACTED] (refer to [REDACTED] or distribution automation projects. This document does not cover drawing formats; these are covered in the ES CAD Drafting Procedure [REDACTED]

All project teams developing automation engineering solutions shall follow this procedure; exceptions are allowed, but shall be documented in the [ES Project Quality Plan](#) (or Vision Quality Tab).

Phase 1 Planning

An Automation Technical Lead (TL) is assigned to manage project scope and technical decisions related to the automation scope of work. As needed, the Automation TL assist the PM with the development of the project plan (scope, schedule, budget), project communication plan, risk management plan, change management plan, etc. as outlined in the ES Project Management Procedure [REDACTED]. The Automation TL also collaborates with the Automation Quality Assurance Owner (QAO) on the development and implementation of QA Checklists. The Automation TL and QAO can be the same person, especially for smaller projects.

- REVIEWS PROPOSAL + BUDGET
- ASM, TEAM
- CLARIFIES SCOPE + DELIVERABLES W/ CUSTOMER
- COLLAB W/ QAO

KEY:

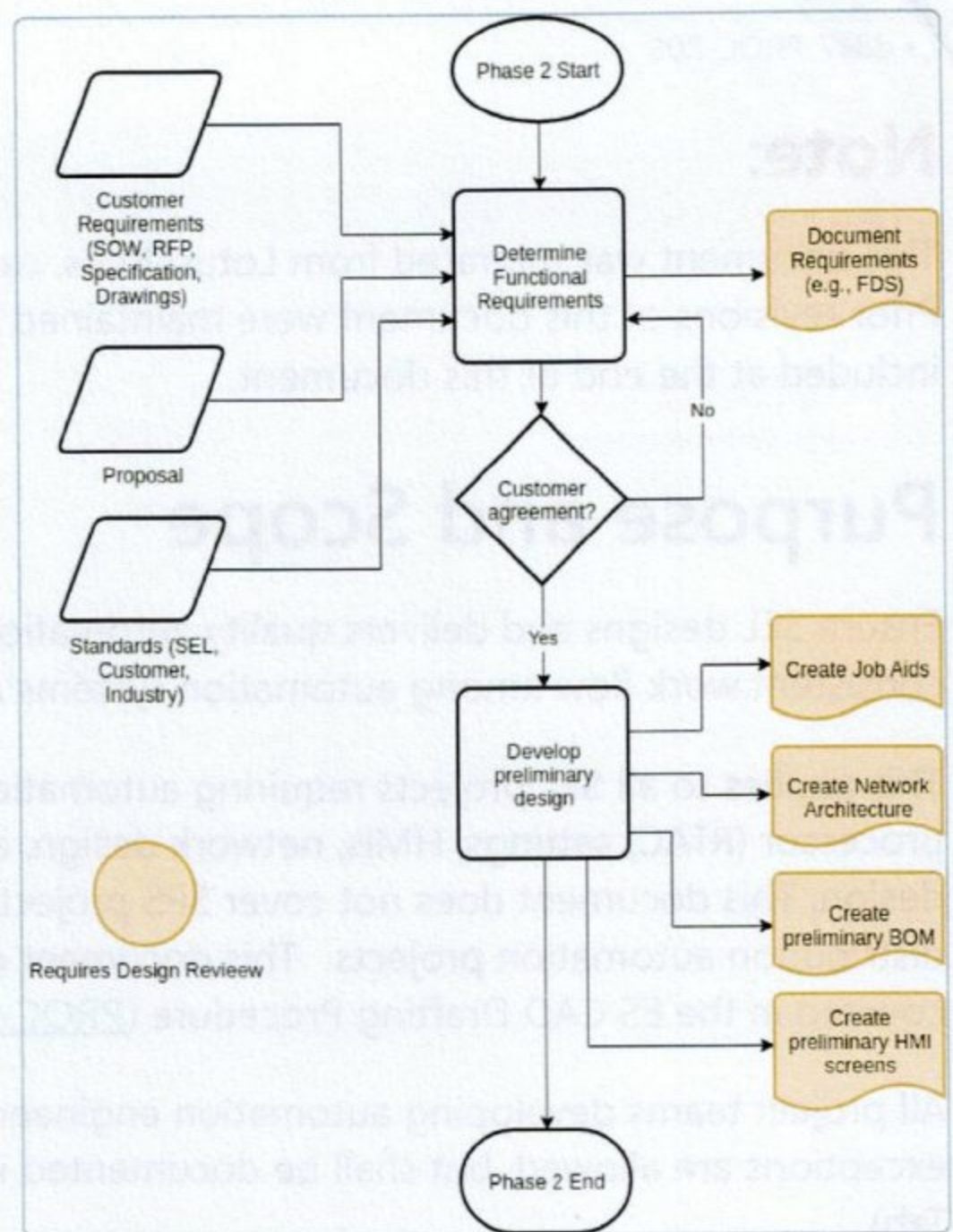
- PLAN
- DEFINE
- DEVELOP
- PHASE GATE APPROACH

Phase 2 Definition

Document Functional Requirements

The Automation TL documents functional requirements based on the requirements in the proposal, bid specifications, scope of work (SOW) clarified in the project kickoff meeting, and applicable customer and/or SEL standards. The purpose of the functional requirement documentation is to verify the customer requirements and manage change. The Automation TL determines the format of the functional requirements which varies for project size and scope of work. For small projects, the functional requirements may be defined in a subsection of the kickoff meeting minutes, but projects with more details and scope should have a standalone document such as a Functional Design Specification (FDS).

Functional requirements for automation may include but are not limited to control systems offered, automation requirements, data collection requirements, device points list, hardware, software, and I/O requirements, etc. For more complex projects, it is recommended that a [Requirements Traceability Matrix \(RTM\)](#) be developed to track how each requirement is met and tested through the life of the project.



Upon agreement on functional requirements from the customer, the PM/TLs modify the project schedule, deliverables, and the Automation QAO modifies QA checklists as required to reflect any new information obtained. The project plan is fully developed, finalized, and reviewed and the PM confirms the SOW, deliverables and schedule for deliverables with the customer.

Create Work Breakdown Structure

The PM leads the team discussion to determine deliverables and process flow between working groups. The conceptual design is discussed and clarified internally. Format of the deliverables between the working groups (Automation, Protection, PM, Drafting) is determined.

Research

Research of topics and products that relate to project specific scope and deliverables. This is to be completed by the Project Engineer, or individual contributor, that owns the creation of the design deliverable. While not limited to, this include the following resource examples:

- ES Standards
- SEL or third party product and software instruction manuals
- Settings requirements for development software
- Past, or similar scope, project as-built references and lessons learned
- Educational material, such as, SEL App Guides and SEL Website Videos
- Test equipment

Job Aids

Job aids are developed and verified with stakeholders. Job aids are spreadsheets, word documents, customer documentation, drawings, and other similar document tools that assist the Automation Engineer with the project engineering analysis and documentation. In addition, job aids are used to communicate information and coordinate tasks with other team members such as Protection Engineers and Designers. The job aids will be used to create templates and further develop project documentation in later phases.

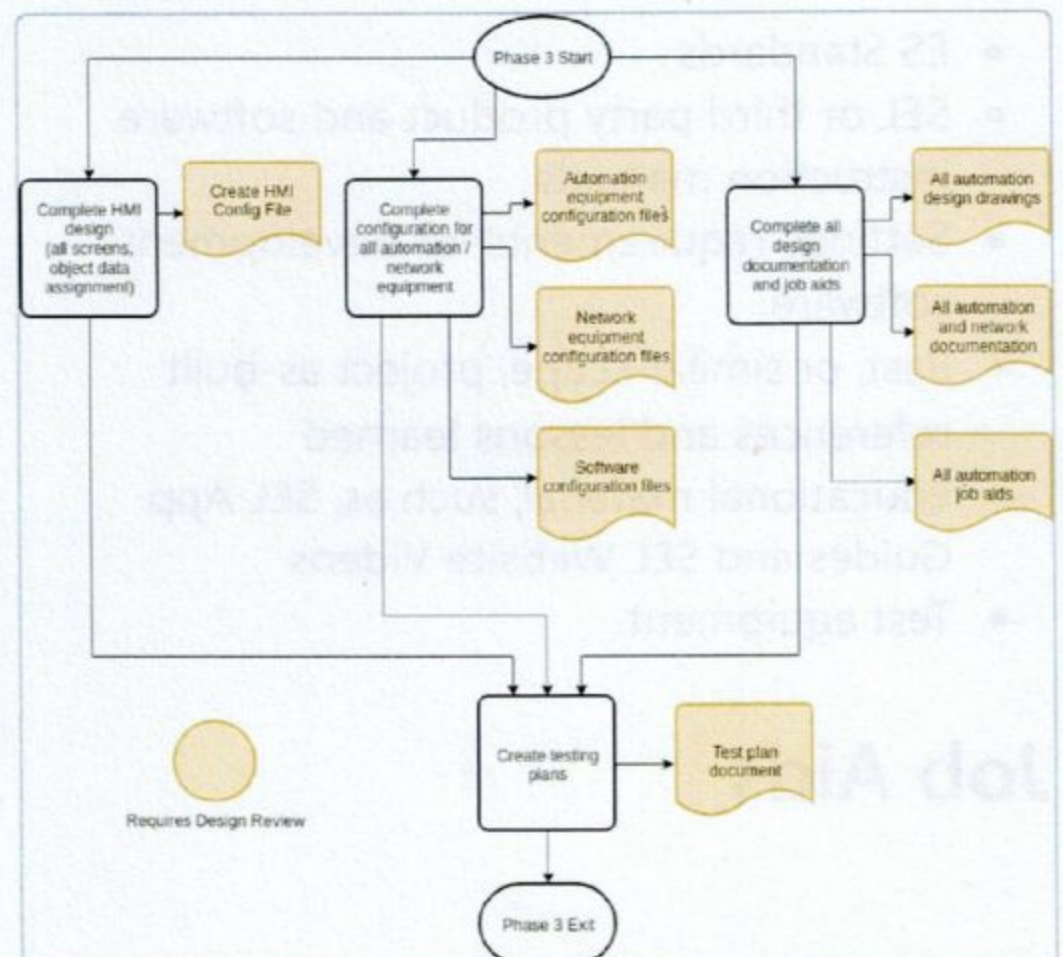
Deliverables Required at Phase 2 Exit

- Customer agreement on functional requirements documentation (e.g., approval of FDS)
- Preliminary design – network architecture (where applicable) and communication one-line diagram
- Approved data points list for communication protocols
- Preliminary bill of materials (BOM)
- Software design specification (where applicable)

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Phase 3 Development

In this phase, the project team implements the design per the project plan outlined in Phase 2. For automation, this phase is broken into three parallel development efforts: HMI configuration, automation and network equipment configuration, and automation design and documentation. The deliverables created during this process should be reviewed using a Design Review Record. The deliverables may also require review by the customer.



Following the completion of these parallel efforts a comprehensive testing plan is developed. This complexity of this plan will depend on the level of testing required. Some ES projects include customer witnessed factory acceptance testing, which can include the assembly of the entire system in a lab environment. This level of testing requires a very detailed procedure. Other ES projects may only include equipment bench testing of configuration files with only a subset of the system assembled. If the project includes customer witnessed testing, then the testing plan should be sent to the customer for review. The testing plan should also be reviewed using a Design Review Record.

HMI Configuration

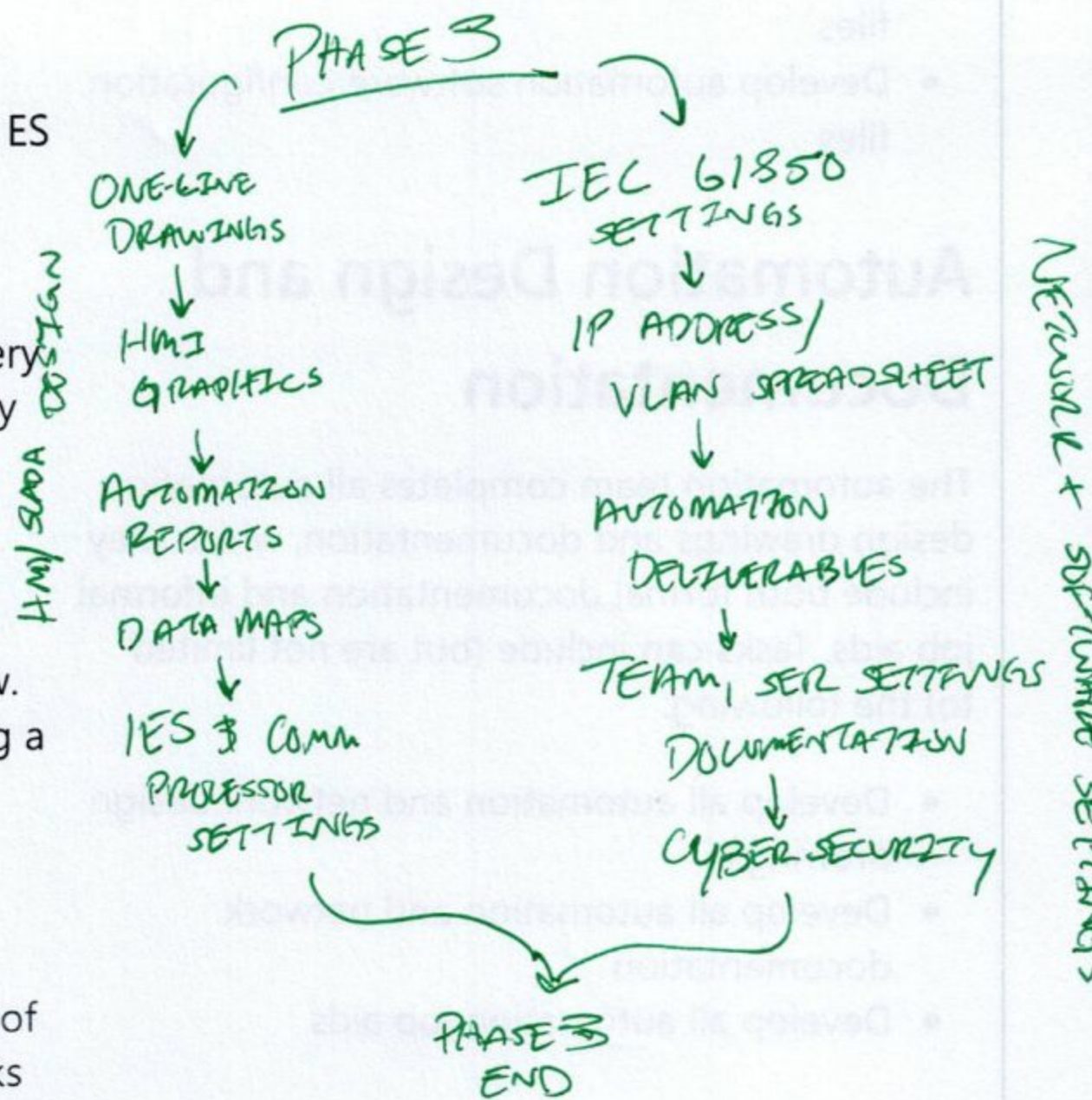
This is only necessary if the system and scope of work include the development of an HMI. Tasks can include (but are not limited to) the following:

- Finish development of all HMI screens, frames, and pop-up control windows.
- Create additional instances of templated screens presented to customer in preliminary design.
- Link all necessary real time data sources to HMI objects (i.e., tag mapping)
- Complete any necessary HMI logic, screen navigation functions, or scripting

Automation and Network Equipment Configuration

The automation team develops the configuration of all automation and network equipment in the system using the preliminary design, job aids, and functional requirements developed in Phase 2. Tasks can include (but are not limited to) the following:

- Develop communication processor configuration files



- Develop network equipment configuration files
- Develop automation software configuration files

Automation Design and Documentation

The automation team completes all automation design drawings and documentation, which may include both formal documentation and informal job aids. Tasks can include (but are not limited to) the following:

- Develop all automation and network design drawings
- Develop all automation and network documentation
- Develop all automation job aids

Deliverables Required at Phase 3 Exit

- All required drawings
- All settings and configuration files for automation equipment, network equipment, and automation software
- Final BOM
- Completed testing plans
- Completed Requirements Traceability Matrix

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Phase 4 Testing and Validation

In this phase the developed system configuration should be tested against functional requirements and any regulatory requirements. The testing should be executed following the plan developed at the end of Phase 3. The project team performs functional tests and validates system performance at SEL prior to delivery using approved test plans to verify each requirement. Any system defects should be logged and tracked to resolution.

Deliverables Required at Phase 4 Exit

- Functional and staged system testing (FAT) reports

- Design review records for updated deliverables and test plans
- Testing/analysis results, findings and actions to close
- For FAT, record of customer review of results
- Performance/validation reports (where required)

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Phase 5 Commissioning

For some projects, ES is contracted to support or carry out commissioning. The Automation TL is assigned to manage scope and decisions related to the automation scope of commissioning.

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Revision history of this work instruction while it was maintained in Lotus Notes

Revision 1; Approved 06/23/2015; Sheila Eickhoff; "Initial Issue of Document. All RMs approved this Procedure via email (Michael B

Sai R

Richard K

Doug S).

4 new procedures are being approved (Project Management Protection

Automation

and CAD Drafting). The new procedures may be implemented immediately on any projects; however

the official effectivity date is 8/1. All new projects started on or after 8/1 must comply with the revised

0204

0205

and 0208."

Revision 2; Approved 04/17/2017; Peter Allen; "Edited wording for clarity."

Revision 3; Approved 10/23/2017; Peter Allen; "Added reference to FORM-0317 Action Item Log Template"

Revision 4; Approved 08/27/2019; Brittany Hart; "Updated Peter Allen's title. CAR-2795: Added note indicating that updates since last Rev are marked in red font. Changed language to align with

exceptions may be made via FORM-0293 or Vision Quality Tab.

CAR-2791: Clarified use of FORM-0314 (RTM)"