

AS9145 – APQP & Layered Process Audits (LPA)

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Understanding APQP & PPAP

Following the lead of the automotive sector, aerospace and defence have now embraced Advanced Product Quality Planning (**APQP**) and the Production Part Approval Process (**PPAP**). APQP standardizes the requirements for the Product Development Process (**PDP**) through the structured use of –

- **APQP methodology**
- **Quality tools/techniques**
- **PPAP** (evidence file)

The methodology, quality tools and PPAP *evidence file* are mandated in AS9145 to which customer-specific requirements may be added (e.g. Rolls-Royce SABRe Ed 3).

The APQP system proactively identifies and corrects potential risks in product design and (manufacturing) process design to guarantee the ongoing delivery of *perfect product* to the customer – zero ppm, on-time, every-time at cost. The 5 phases of APQP comprise of *activities* (processes) and their *deliverables* (outputs) which collectively provide objective evidence that all tasks have been successfully completed. Much of this evidence is included in the PPAP submission to the customer concerned for review and approval.

Once serial production (i.e. post First Article Inspection) is underway, these APQP *deliverables* are used to ensure that the product is manufactured under the specified *controlled conditions*. Key documentation include –

- **Process Layout Diagram**
- **Control Plan**
- **Work station documentation** (i.e. work Instructions, inspection instructions, travelers, SPC charts, maintenance schedules, etc.)

Nevertheless, there remain *two* lurking problems –

1. the APQP processes themselves may not have been undertaken in conformance with AS9145 requirements by competent cross-functional teams using the stipulated quality tools
2. there could be a lack of consistency in working to the manufacturing *controlled conditions* at the shop-floor level! If left unmonitored, experience has shown that such mission drift is inevitable

To proactively prevent these problems two different types of highly focused auditing methods must be deployed which are over and above the internal audit programme.

APQP Audit

This audit augments the routine QMS internal audits carried out by quality assurance teams. It is more thorough and uses a larger sample size of completed APQP & PPAP projects. APQP System Audit *questions* target –

- AS9145 requirements
- each of the APQP phases
- all phase elements
- competency of cross-functional teams
- use of quality tools
- phase deliverables/outputs

The APQP system audits should be carried out by quality/production engineers and Continuous Improvement Practitioners familiar with AS9145 requirements and having a practical knowledge of the necessary quality tools and the resulting deliverables/outputs.

TEC recommend the use of *checklists* to ensure that all elements of each APQP phase are addressed in a consistent manner. Audit decisions and evidence are recorded with

required actions/times assigned to the personnel responsible for the phase involved as with routine QMS internal audits.

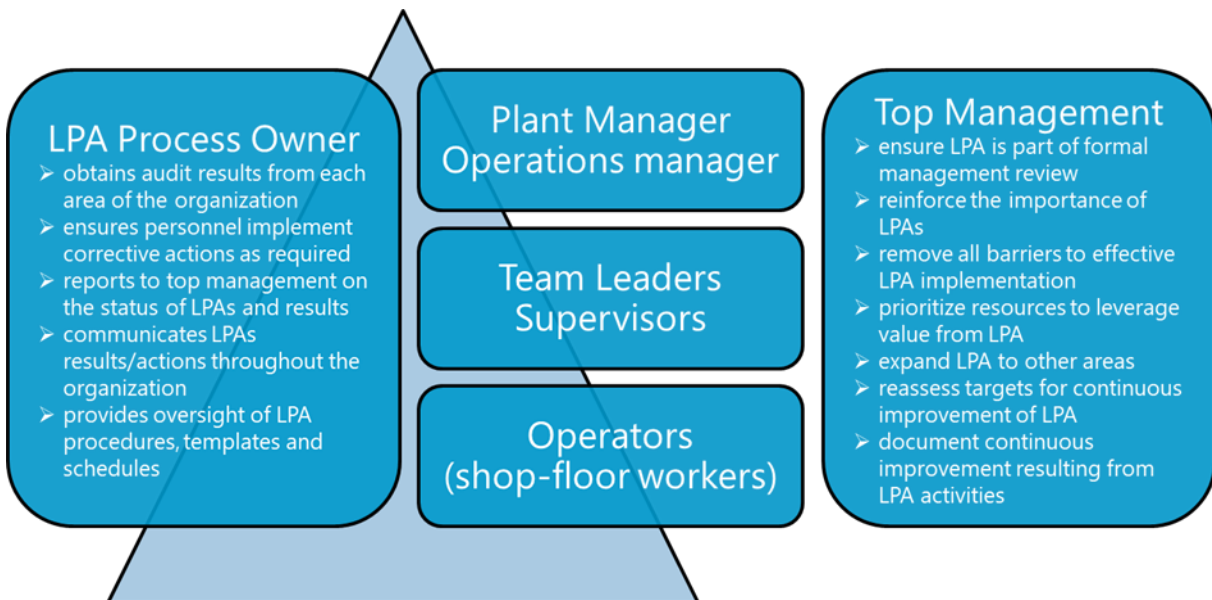
Layered Process Audit (LPA)

A Layered process audit (LPA) is a workplace activity focused on observing and verifying how products are made, rather than inspecting finished products. The LPA looks at the *process elements* involved in manufacturing/service delivery. The LPA scope is every department/area involved in manufacture/service delivery.

LPA personnel

LPA derives its name from the requirement that multiple “layers” (i.e. personnel at various levels) of an organization conduct the audits.

- **Not** the QA Manager nor the QMS Audit Team, but –
- operators (shop-floor workers)
- team leaders and supervisors
- department managers and top managers (e.g. the plant manager)



The assigned multi-layer personnel conducting the LPA use the same bespoke check-sheet questions – delegation is not acceptable!

LPA programme

To create the LPA programme, the organization's team must define the layers as well as the frequency for each layer. It is advisable to designate a *LPA Process Owner* is responsible for the following –

- obtaining audit results from each area of the organization
- ensuring personnel implement corrective actions as required
- report to top management on the status of LPAs and results
- communicate LPAs results/actions throughout the organization
- provide oversight of LPA procedures, templates and schedules

Ideally, the LPA Process Owner should be the organization's Operations Manager or at least a member of the Top Management team. Never, under any circumstance, should the job be 'abdicated' to the Quality Manager!

Manufacturing/service processes are selected based on risk to product/service quality including lessons learned, safety, criticality of process step, or product characteristic. Start by reviewing process performance (KPIs) and identify which processes are causing problems –

- highest severity
- highest frequency (occurrence)

Also consider –

- high safety incidents/MORs/injuries
- high risk/severity from the PFMEA

- high number of customer complaints/CARs
- high scrap/re-work rate
- low machine efficiency
- process runs longer than intended

LPA takes place at the location where work is being done, and follows the Toyota Production System (TPS) philosophy –

- *Gemba* – “the actual place” – where work takes place
- *Gembutsu* – “the thing” – i.e. operators, work documents, tools & equipment, machines, product, etc. it is the target of your focus
- *Genjitsu* – “the facts” – what is happening in the area, manufacturing cell, etc.

LPA check-sheet questions

A crucial element of LPA deployment is defining the *check-sheet questions*. Each *question* is listed with an associated *explanation* of why it was selected.

Each question also has a pre-defined *reaction plan* – i.e. how the auditor is to react if a nonconformance is found.

Question	Explanation	Reaction Plan
<p>What/Where/How to check</p> <p>Intended to verify general work elements that have a <i>direct impact</i> on quality or are likely to <i>vary</i> day-to-day</p> <p>Review relevant risk aspects (e.g. PFMEA, Turtle Diagram, Ishikawa Diagram)</p>	<p>Why the question was selected</p> <p>All questions must have a defined <i>purpose</i> and an expected response. Answering “Why?” underlines the value of the question and its relationship to KPIs, controls and the process</p>	<p>How the auditor is to react if a nonconformance is found</p> <p>e.g. a <i>pre-established</i> reaction plan to prompt the responsible individual to correct the situation –</p> <ol style="list-style-type: none"> 1) <i>action #1</i> 2) <i>action #2</i> 3) <i>action #3, etc.</i>

LPA questions concentrate the auditor's attention on process *controlled conditions* i.e. the APQP *deliverables*. Consequently, the first step is to identify the 'sources' of these necessary controlled conditions –

- work instructions (elements)
- competent personnel
- criteria for workmanship
- job-specific tools/equipment
- infrastructure and environment
- control/monitoring of CIs and KCs
- checking/inspections/testing
- correct measuring equipment

A cross-functional team involving departments/cells should hold discussions to seek input, information and ideas to develop the check sheet questions for the LPA – classic *Nemawashi* (translated as "prepare the soil"). The questions should include whatever the organization believes is critical to product quality. The items are typically those that pose a high-risk to customer satisfaction and/or product safety and durability. Consideration must also be given to the status and importance of the related process.

The set of LPA questions must be updated as required to incorporate the latest improvements and process updates based on audit findings, employee suggestions, etc. This *standardized*, common set of questions will be used during LPA.

Processes, procedures, work instructions and other aspects of the business that are critical to ensure product quality are items that should be considered. When selecting items for a LPA, the team may consider the status and importance of the related process.

Scheduling the LPA

Identify the locations (e.g. manufacturing cells) where LPAs will take place – LPAs should concentrate where they will be most effective. LPAs must be completed on a regular, pre-determined frequency.

Set up a *Layer 1* (operators, shop-floor workers) audit schedule for each location/cell to cover all shifts (as applicable).

Layered Process Audits should –

- take 10- to 15-mins
- include 5- to 10-questions
- be performed every day
- cover all shifts (if applicable)

Frequency of LPAs is adjusted depending on the results obtained (i.e. number of nonconformances).

Schedules of LPA for '*higher-levels*' of management will be less frequent –

- *Layer 2* (middle management) – weekly/monthly
- *Layer 3* (plant managers, directors) – quarterly/annually

Management must be involved in updating the LPA schedule. The schedule must be approved by the location (cell) management.

Once established, the audit schedule should be followed, and results recorded.

LPA verification of controlled conditions

A LPA verifies that work is done according to established standards (Work instructions; Workmanship standards; etc.) therefore its focus is on controlled conditions –

- emphasizing the importance of (work) standards
- detecting and correcting all nonconformances
- identifying opportunities for improvement

LPA is more 'verification' rather than 'conventional audit' –

- LPA audit results are is/is not
- Key Characteristics (KCs) capability indices (C_{pk}) checked
- Process KPIs always examined

The underlying cause of most deficiencies will be a lack of process standardization or simply a failure to follow the controlled conditions detailed in workstation documentation. Never accept the *excuse*: "it was down to operator error". Determine the *human factor* that was the root cause and devise an effective countermeasure.

KPIs for monitoring LPA effectiveness

There is a need to monitor (and actively manage) the output of the LPA programme. Here are some obvious performance measures –

Metric	Measures
Percent of LPA completed (by layer)	Implementation of the programme and assigned LPA priority at each level
Percent conformance (by Area/Cell)	Percent of elements checked that were observed to be in conformance with defined controlled conditions (work instructions, m/c settings. etc.)
Corrective action completed and closed (by Area/Cell)	On-time completion of corrective actions
Repeat nonconformance in LPA	Efficacy of corrected actions (prompt need for 8-D)
Key Performance Indicators (KPIs)	Efficacy of the LPA programme in terms of the effect operating metrics (RFT, ppm, C_{pk} , etc.)

A LPA is specifically designed to uncover nonconformances in the workplace. Should a LPA shown a very high compliance, the questions may need to be re-evaluated or the targets of the LPA changed

Benefits of APQP audit & Layered Process Audit (LPA)

The APQP audit augments the routine QMS internal audit and provides a deeper coverage of the APQP system. Its focus is on providing a true picture of the extent to which the five phases are being undertaken for all products – with particular attention on the correct use of the quality tools and the phase deliverables/outputs. These deliverables will include work station documentation destined to be used by the operators to produce *perfect product*.

Unlike QMS internal audits where corrective actions must always be undertaken by the auditee, with LPA the auditor is actively involved in correcting problems/nonconformances. – it's an immediate fix reminiscent of *Kaizen Blitz*.

Remember, operators, supervisors, department managers, plant managers, and company directors conduct the LPA. The LPA places people of multiple levels of the organization "where the work is being done" to verify critical items. This facilitates communication between management and the shop-floor team members.

Above all, the LPA demonstrates to all team members that following working instructions 'to the letter' is very important – "if the plant manager is here to verify that it is done, it must be critical!"

The deployment of both the APQP audit and LPA will help instil a culture of *zero-defects* throughout an organization – zero ppm, on-time, every-time at cost.

For more LPA information, visit our webpage – *AS9145 – APQP & Layered Process Auditing (LPA)* [<https://tectransnational.com/training-and-qualification/as9145-apqp-and-manufacturing-process-auditing>]

For more information on our AS9145 programme of training, visit our webpage – *AS9145 – APQP & PPAP training programme* [<https://tectransnational.com/support-and-collaboration/as9145-apqp-and-ppap-training-programme>]
