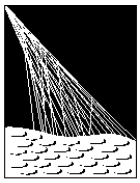

PIERRE AUGER OBSERVATORY

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PIERRE AUGER OBSERVATORY

SURFACE DETECTOR ELECTRONICS

QUALITY MANAGEMENT PLAN

For the design, development, production, installation and maintenance of the surface detector electronics (SDE) intended to equip the Pierre Auger Observatory for high energy cosmic ray detection.

DOCUMENT HISTORY

N°	WRITTEN		VERIFIED		APPROVED	
	by	date	by	date	by	date
1	**Yves C. ADES**	**April-11-2002**	**Tiina SUOMIJÄRVI**	**April-12-2002**	**Jamie BLOWERS**	**April-12-2002**
0	*Yves C. ADES*	*Mar-3-2002*	*Tiina SUOMIJÄRVI*		*Draft Only*	

1. SUMMARY

2. REFERENCE QUALITY STANDARDS

2.1. QUALITY MANAGEMENT PLAN PURPOSE

The Surface Detector Electronics (SDE) task is carried out by a large international collaboration and by using several subcontractors

This Quality Management Plan is established and maintained in order to describe the quality management system used within the Surface Detector Electronic group (SDE) of the Pierre Auger Observatory (PAO).

It describes the policies and procedures for assuring the performance and reliability of the SDE.

2.2. SDE PROJECT REFERENCE QUALITY STANDARDS

This document is built to fulfill requirements of the International Quality Management Standard ISO 9001 : 2000.

It specifies how the policies and procedures approved for the PAO in general are to be applied in the SDE Task. The general policies and procedures are described in the general Pierre Auger Observatory Quality Assurance Plan (PAO/QAP).

2.3. CORRESPONDENCE WITH PIERRE AUGER OBSERVATORY QA PLAN

In order to facilitate correspondence between the PAO/QAP (based on the former ISO9001 : 1994 Standard) and this Quality Management Plan for the SDE Task (based on the new ISO 9001 : 2000 standard), a correspondence table is provided hereafter :

Correspondence table between PAO Quality Assurance Plan and SDE Quality Management Plan :

SDE/QMP references (based upon ISO 9001 : 2000)	PAO / QAP references (based upon ISO9001 : 1994)
1 Summary	
2 Reference quality standards	
2.1 Quality Management Plan purpose	1 Purpose
2.2 SDE project reference quality standards	1 Purpose
2.3 Correspondence with PAO QA plan	
3 Vocabulary, symbols and abbreviations	
4 Quality Management System	4.2 Quality system
4.1 General requirements	
4.2 Documents of the Quality Management System	3 Related documents
4.2 SDE Document structure and control	4.5 Document and data control + 4.16 Control of quality records
5 Project management responsibility	
5.1 Project vs. Task organization	4.1.2 Organization structure
5.2 Communication and interface to the PAO	4.1.2 Organization structure + 4.4.3 Organizational Interface
5.3 Communication and internal interface within the SDE task	4.1.2 Organization structure
5.4 Quality policy of the SDE development	4.1.1 Policies and objectives
5.5 Roles, responsibility and authority	4.1.2.1 Roles, responsibility and authority
5.6 Management review	
5.6.1 General	
5.6.2 Management review information : input	
5.6.3 Management review information : output	
6 Management of resources and planning	
6.1 Provision of resources	
6.2 Manpower and human resources	4.18 Training and qualification
6.3 Installations and facilities	
6.4 Working environment	
7 Process Management	4.9 Process control
7.1 General process mapping	
7.2 Communication process	4.3 Contract review
7.2.1 Technical specifications	
7.2.2 Specification reviews	4.3 Contract review
7.3 Design and development	4.4 Design
7.3.1 Design and development phases	4.2.3. Quality planning
7.3.2 Design input	4.4.4 Design input
7.3.3 Design output	4.4.5 Design output
7.3.4 Design review	4.4.6 Design review
7.3.5 Design verification	4.4.7 Design verification
7.3.6 Design validation	4.4.8 Design validation
7.3.7 Design changes	4.4.9 Design changes
7.4 Purchasing and subcontracting	4.6 Purchasing
7.4.1 Purchasing process	4.6.1 (Purchasing) Policy + 4.6.2 Evaluation of subcontractors
7.4.2 Purchasing information	4.6.3 Purchasing data
7.4.3 Purchased material, equipment and service acceptance	
7.5 Production, installation and service	
7.5.1 Process control	4.9 Process control + 4.19 Maintenance
7.5.2 Process validation	4.9 Process control
7.5.3 Product identification, labelling and traceability	4.8 Traceability + 4.12 Inspection and testing status
7.5.4 Cross Task product care	
7.5.5.Handling, shipment, packaging and storage	4.15 Handling, storage, packaging and delivery
7.6 Control of measuring and test devices	4.11 Control of measuring and test devices
8 Quality improvement system	
8.1 General description of the quality improvement process	
8.2 Inspection and testing	4.10 Inspection and testing
8.2.1 Project satisfaction	
8.2.2 Quality audits	4.17 Quality assessment
8.2.3 Assessment of process quality	
8.2.4 Assessment of product quality	
8.3 Control of non-conforming products	4.13 Control of non-conforming products
8.4 Data analysis and statistical techniques	4.20 Statistical techniques
8.5 Improvemant plan	
8.5.1 Continual improvement plan	
8.5.2 Corrective action control	4.14 Preventive and corrective actions
8.5.3 Preventive action control	4.14 Preventive and corrective actions

3. VOCABULARY, SYMBOLS AND ABBREVIATIONS

Specific vocabulary, usual abbreviations and symbols used in this QMP are listed below for a better understanding :

Corrective action		Action undertaken in order to eliminate causes of non-conformity or any other undesirable situation so that it has no more negative effect and will not re-occur.
Engineering Data Management Service	**EDMS**	Document and data computerized system which can be accessed via http://www.auger.org/admin for storage and retrieval of PAO shared documents and data.
Preventive action		Action undertaken in order to eliminate causes of a potential non-conformity or any other undesirable situation so that it does not develop.
Purchasing request	**PR**	Any document used by a member of the SDE group, to introduce a purchase order to an outside vendor. .
Quality Record		Written or computer stored information to keep track of any event, measurement or test results whenever required by the SDE/QA system.
Template		Document (paper or computer) used to establish and keep quality records (also « forms »)
Vendors		Any company, laboratory or other organization, not listed as part of the PAO project, used to supply material or service contributing to the project.
Non-conformity		Situation where there is evidence that an explicit requirement of the QA system has not been verified or has shown during test or verification, that it does not comply with any explicit requirement.
Quality Management Plan And Quality Assurance Plan	**QMP SDE/QMP PAO/QAP**	Booklet written to describe the management system as applicable to the PAO or part of it. The quality management system applicable to surface detector electronic is referred to as SDE/QMP or QMP. The overall QAP applicable to the Pierre Auger Observatory project is always referred to as PAO/QAP
Quality improvement action plan	**QIAP**	Action plan defined and applied in order to improve SDE quality.
Procedures		Written documents describing how to accomplish certain processes, sub-processes or key tasks whenever required to obtain expected quality level.
SDE project QA correspondent	**SQAS**	Within the SDE group, person in charge for definition, formalization and verification of the QM system. The SQAS has the group leadership authority to enforce quality commitments and actions.
Surface Detector Electronics	**SDE**	

4. QUALITY MANAGEMENT SYSTEM

4.1. GENERAL REQUIREMENTS

This Quality Management Plan is based on the PAO Quality policy and describes :

- the processes required to obtain the Surface Detector Electronics required for the project, as included in the SDE task,
- the interfaces between sub-tasks of the SDE group,
- the criteria used to control sustained quality of the SDE task results,
- the methods used to insure resource and information availability within the SDE task group,
- the measurements methods, techniques and systems used for SDE testing,
- the methods and records used to obtain expected results and continual improvement of the above.

4.2. DOCUMENTS OF THE QUALITY MANAGEMENT SYSTEM

This QMP is the key document to describe the quality assurance program developed and maintained in order to satisfy quality requirements with the surface detector electronic assembly, its process and the organisation implemented in the SDE task group.

Its complies with the requirements expressed in the PAO general quality plan, and calls for internal SDE task quality documents such as :

- documents created and maintained to identify all processes contributing to the quality of SDE,
- documents and information describing how individual processes interconnect with each other

documents describing design, procurement, manufacturing, and test methods used as well as decision criteria,

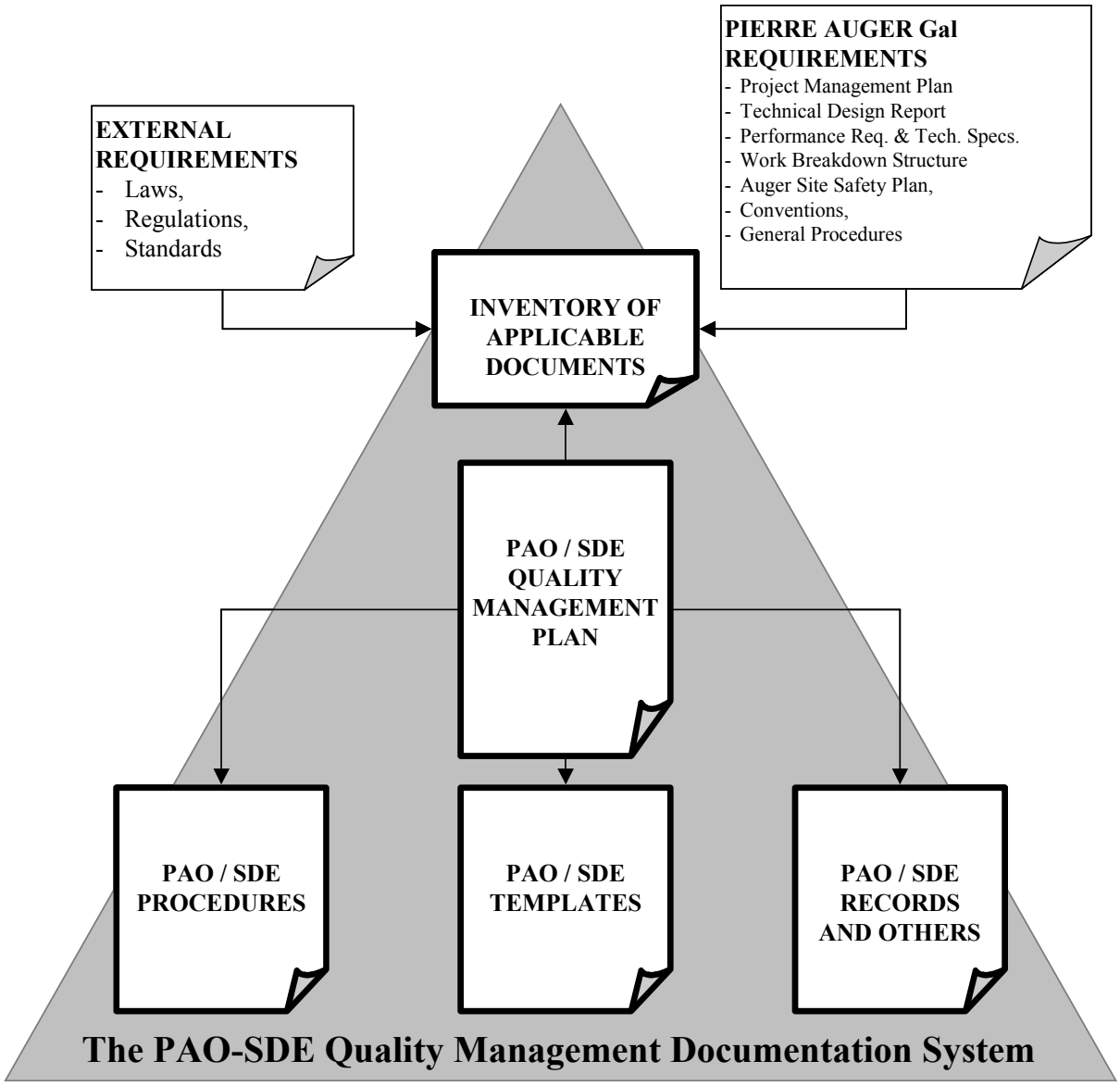
- documents which describe how the task group is managed and controlled, how compliance is to be verified and how coherence between objectives, planning and resources is being maintained,
- records of decisions, tests and verification,
- principles, documents and information which describe actions intended to maintain and improve the quality of SDE, its process and the task group organization.

4.2.1. SDE document structure and control

The following diagram represents how the documentation which applies to the SDE task group is classified for better retrieval. A particular document, entitled "**Inventory of Applicable Documents**" has been created and is maintained in order to identify the existence and status of all these documents. This classification separates fives types of documents :

- **Laws, regulations and standards** : these are all documents binding to the development of the task, published with no responsibility within the PAO project which must be known to avoid non-compliance. It typically includes country laws and regulations that apply to the Task group as well as accepted Standards.
- **PAO Project documentation** : this category includes all documents, published and approved at the PAO project level, which applies to the SDE Task group,

- **SDE task documentation** : includes this Quality Management Plan as well as all procedures, instructions, specifications and recommendations decided and approved within the task group to obtain and maintain the expected quality standards,
- **Templates and models** : includes all forms, templates and computer screens to be used for communication within the task group and/or record information for traceability,
- **Notes and others** : includes all documents developed at the project or task level, which may not be binding for the task group but bring necessary guidance or information.



The PAO-SDE Quality Management Documentation System

4.2.2. Quality Management Plan

It is established by the SDE Task Quality Correspondent in compliance with the project quality policy, verified by the SDE Task Lleader and approved by the PAO Quality Manager prior to release. It is made available to all participants to the SDE Task after approval. Older versions are removed upon approval of a newer version.

4.2.3. Document management and control

The principles of document management and control applicable to the task group follow the **SDE Task document and data control procedure**.

Concerning the SDE task, the following documents are maintained under document control: (authorized personnel are defined in parenthesis):

- SDE Quality Assurance Plans (QA Manager, SDE Task Leader, SDE task QA Correspondent)
- Released engineering drawings (SDE Task Leader, Systems Engineer)
- Procurement specifications (SDE Task Leader)
- SDE Performance Requirements and Technical Specifications (SDE Task Leader)
- SDE Test Plan (SDE Task Leader)
- Cost Estimate (WBS) (Project Manager, SDE Task Leader)

Other task level documents are released when approved by the Task Leader.

Subtask Groups are responsible for the control of documents and data associated with the procurement of materials for their Subtask.

4.2.4. Quality record management and control

The principles of Quality record management and control applicable to the task group follow the **SDE task Quality Assurance Record control procedure**.

Whenever available and listed in the **Inventory of Applicable Documents**, records must be established using the appropriate template or form.

Other records required for process traceability must be kept at the subtask level under a form transmittable to the following subtask group along the general process and retrievable at any time for standardization until the southern array is in operation.

5. TASK MANAGEMENT RESPONSIBILITY

5.1. PROJECT VS.TASK ORGANIZATION

The organizational structure of the Auger Project is defined and documented in the Project Management Plan.

The general coordination of SDE task is ensured by task leader and co-task leader.

The responsibility of maintainig an appropriate Quality Management System is devoted to the Task Quality Correspondent.

Individual assignements within the Task group as well as sub-task organisation is described and modified by notes, entiltled "SDE Organization and assignements" published, approved and released by the Task Leader

The different sub-systems of the SDE (see TDR) and the corresponding responsibilities are given below.

5.2. COMMUNICATION AND INTERFACE TO THE PAO

Communication and interface between the SDE Task and the PAO management follows the general PAO Standards.

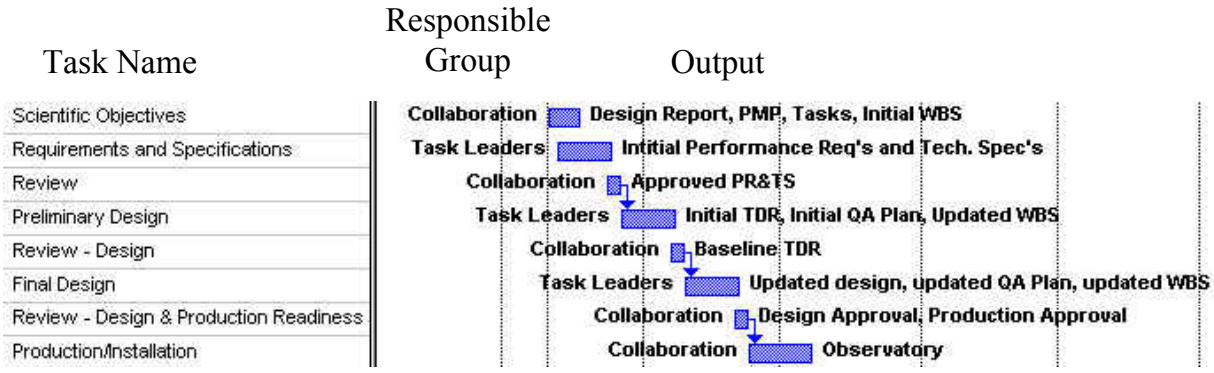
5.3. COMMUNICATION AND INTERNAL INTERFACE WITHIN THE SDE GROUP

Communication between different Subtask Groups is ensured by SDE Workshops being held every 2-3 months, phone conferences and electronic mail. GAP-notes on different systems are available and other technical documentation is available and being updated on the web pages of different groups. Documents and records required for communication about this plan are made available on the EDMS (Engineering Data Management System).

5.4. QUALITY POLICY OF THE SDE DEVELOPMENT.

In accordance with that of the PAO project.

The overall planning of quality proceeds as follows:



5.5. ROLES, RESPONSIBILITY AND AUTHORITY

Roles and responsibilities within the Task Group and at the subtask level are defined in the Project Management Plan.

Due to the critical size of the SDE task group, a Quality Management (QM or QA)correspondent is attached to the Task Leader with same role and responsibility, at the Task level as the QA manager at the Project level.

5.6. MANAGEMENT REVIEW

5.6.1. General

Once a year, the SDE Workshop is organized so that it includes a formal Quality management review. The task leader or co-task leader AND the Quality Management correspondent are present at that time, along with subtask leaders for a thourough quality status and progress review which includes the following topics :

5.6.2. Management review information : input

Task Quality management reviews are intended to scan, systematically, the following information :

- Quality audit results and action plan status (by Project QA Manager),
- Project manager statement of task quality results (by Project Manager,
- History of non-conformity processing (by Task QA Correspondent),
- Review of Continual Improvement Status (by Task QA Correspondent),
- Review of Quality Management System evolution (by Project QA Manager),
- Other recommendations for improvement (by Task Leader).

5.6.3. Management review infromation : output

Task Quality management reviews are intended to lead to decisions and actions on the following topics :

- Actions for improvement of the processes and the QM system,
- Actions for improvement of the Surface Detector Electronics itself,
- Evaluation of actual resource requirements,availability and planning

These actions must be included in the minutes of the quality management review and included in the action plans.

6. MANAGEMENT OF RESOURCES AND PLANNING

6.1. PROVISION OF RESOURCES

Resources for the task group include :

- human resources within the project personnel,
- material, facilities and equipment,
- financial resources in order to satisfy the above as a function of expected results.

Verification must be done, at the task and subtask levels, that resources are in accordance with planned deliverables.

Any situation leading to identify that resourses will not allow to meet expected delivery planning must be reported immediately to the task leader, whenever they can be anticipated or identified.

Financial resource allocation methods are decribed in the **Project Management Plan** under sections « Commitments » and « Cost estimation, tracking and control ».

The formal contract between the Pierre Auger Collaboration and the participating institutions is the **Memorandum of Understanding** (MOU). This document details the scope of work, deliverables, the level of contribution to the common fund, the work schedule, and funding arrangements.

Concerning the SDE task, the MOU of participating institutions is signed by the SDE Task Leader.

6.2. MANPOWER AND HUMAN RESOURCES

Personnel assigned to subtasks contributing to the SDE task should, in accordance with the prject policy, be hired for the duration of the project, whenever possible, and posess the appropriate level of skill, experience, and academic qualifications to support the achievement of the Project's mission.

Qualifications for personnel working on the Auger are based upon the responsibilities of the position and project needs, which define the level of education, extent of work experience, knowledge and specific skill requirements.

Concerning the SD Electronics, training is to be planned and provided in the following areas :

- Receiving inspection and storage on site
- Electronics installation on site
- Functionality test after installation
- Deployment in the field and field test
- Maintenance procedure and equipment
- English language

The Subtask Groups are responsible for planning and providing instructions and training for these areas. The training should be planned for the preproduction phase, in order to have qualified personnel for the production process and be recorded for traceability.

If the Task Leader determines resources levels are inadequate for fulfilling the task requirements, as documented in the WBS and MoUs, then the Task Leader works with the Pierre Auger Project Manager to determine an appropriate solution.

6.3. INSTALLATIONS AND FACILITIES

Each Subtask Group determines the facilities, equipment, tools and material required to meet specifications and deadlines of the project, which are maintained during the whole project duration.

Installations and facilities are determined in such a way that they can be accessible by the Task leader for review and / or audit upon short notice. This is also true for suppliers or sub-contractors to the SDE Task.

6.4. WORKING ENVIRONMENT

Each Subtask Group determines appropriate working environment for activities to be performed, including all applicable safety regulations.

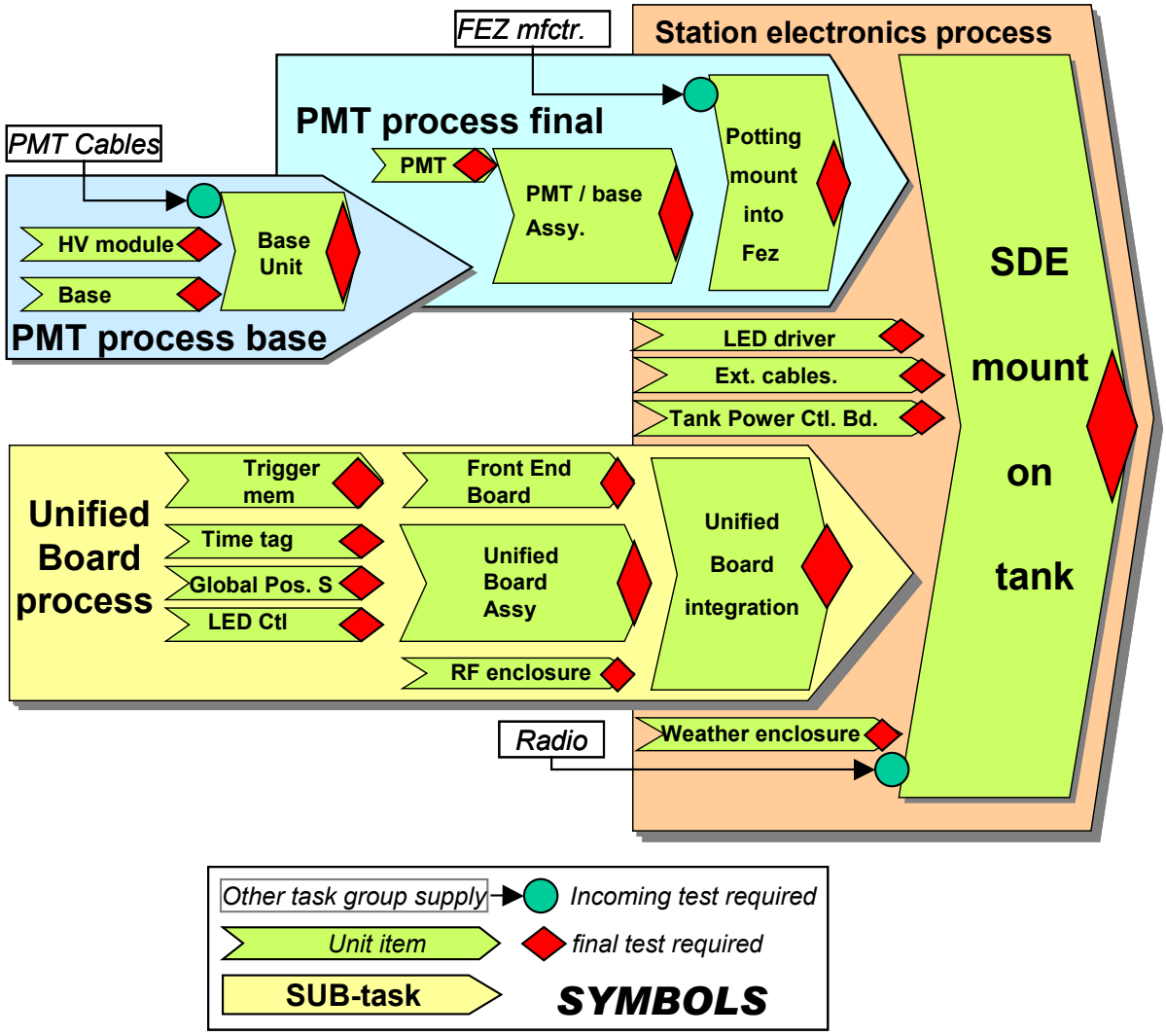
While operating on the installation site or for maintenance purposes, all task members are instructed and respectful of the local safety and envronmental requirements.

7. PROCESS MANAGEMENT

7.1. GENERAL PROCESS MAPPING

The process involved with the SDE Task includes specification, design, development, production, installation and maintenance of the Surface Dectector Electronics for the Obsrevatory.

The following diagram represents the SDE production process and the articulation of each subtask (i.e. subprocesses) and each activity identified by the item it produces.



SDE task general process mapping

7.2. COMMUNICATION PROCESS FOR PAO SATISFACTION

In order to obtain satisfaction of the PAO objectives, the policy is to establish communication and relations based on a formal contract.

The formal contract between the Auger Collaboration and the participating institutions is the **Memorandum of Understanding** (MOU).

For institutions that have signed an MOU, an Amendment to the MOU is issued and approved as needed. This amendment defines the changes to requirements, resources, and deliverables for the collaborating institution.

The Project Management Office maintains signed MOU's and Amendments.

For the SDE task, the MOU of participating institutions is signed by the SDE Task Leader and evolves when amaendments are being issued and approved.

7.3. DESIGN AND DEVELOPMENT

Principles of design and development, for the SDE task, are based on the PAO policy as expressed in the **Pierre Auger Observatory Quality Assurance Plan**.

7.3.1. Design and development phases

Development phases are described on the diagram § 5.4 above.

The SDE Task Group of the Project maintains a plan that describes the activities associated with the Task, entitled "**SDE design and development plan**" which defines the responsibility for the implementation of the activities. This plan is based on the **Project Management Plan** and the **Work Breakdown Structure**.

7.3.2. Design input

The SDE task design inputs are defined by the Task Groups responsible for the subsystem in question and they are documented in the **Performance Requirements and Technical Specifications** document. These requirements are based on the Design Report and the experience/knowledge of the members of the Task Groups. The design inputs are reviewed and approved by formal design reviews before they are used to manufacture the SD Electronics.

7.3.3. Design output

The **Technical Design Report**, the subsequent drawings and technical notes are the outputs of the design process, and constitute the baseline design configuration.

This information contains (or makes reference to) performance requirements (i.e. verifiable criteria).

These documents go through formal design reviews before they are approved. The review includes verifying them against the design inputs and specifications.

7.3.4. Design review

At appropriate stages of design, formal documented reviews of the design results are planned and conducted.

Planning of design reviews is determined by the SDE task leader based on the principles expressed in the **Pierre Auger Observatory Quality Assurnace Plan**.

Concerning the SDE Task these reviews are:

- Preliminary Design Review
- Critical Design Review
- Minireview: These reviews are supplementary to the Preliminary and Critical
- Design Review defined in the general QA Plan. Their purpose is to examine the conformity of a specific part or subsystem of the SD electronics in order to allow a corrective action, if necessary, in early phase of the design. Minireviews are organized by the Task Leaders and/or by the concerned Task Group. They use outside experts who examine the design and propose corrective actions. Reports of the minireviews are communicated to the Task Leaders.

7.3.5. Design verification

Design verification is normally done through design reviews. It includes verifying the technical design of subtasks in progress and verifying that the appropriate process, documentation and traceability of design pases and outputs has been accomplished.

7.3.6. Design validation

Designs are validated through the testing of the complete prototype system (or subsystem) during and after assembly, against the performance requirements. Results of validation testing for each sub-task is documented as a Quality record

If a subcontractor is used, the subcontractor validation depends on the performances of the prototypes supplied by the subcontractor and tested by the Subtask Group.

7.3.7. Design changes

Appropriate design controls are incorporated into the project by using configuration management. The Configuration Control Board (CCB) controls design changes (see the **Project Management Plan** for details of the CCB). Design changes are also updated in the **Technical Design Report** and other related documentation.

All design changes that are proposed by the Subtask Groups must be recorded using the **Engineering Change Request** template and be approved by the Task Leaders and go through a formal design review (Minireview for minor changes).

In order for the new design to be approved, it must be demonstrated to the review board that either the old design is not adequate, or that the new design has superior performance and/or cost advantage(s) over the old. Once approved, the **Enginnering Change Request** and its attached documents become an **Engineering Change Report** ans is included as a Quality Record in the design traceability files.

7.4. PURCHASING AND SUBCONTRACTING

7.4.1. Purchasing process

Purchasing and subcontracting activities required by the SDE Task group are made in compliance with the policy expressed in the **Pierre Auger Observatory Quality Assurance Plan**.

Within the SDE task group, each sub-task leader is in charge of identifying appropriate suppliers for itemes to be procured or services to be rendered.

Procured items and services are classified in three categories, depending on their possible impact on the SDE final quality :

- critical items or services, considered as essential for the overall quality, in the respect that their absence or failure leads to a system malfunction requiring repair or replacement ("**CC**" items),
- sub-critical items or services, which must be available for production and operate according to specifications, but do not lead to compulsory immediate repair in case of failure ("**SC**" items)
- non-critical items or services, which are required by the SDE or the process, but have no direct effect on the SDE satisfactory operations ("**NC**" items)

Sub-Task Leaders are responsible for selecting subcontractors on the basis of their ability to meet short as well as long term requirements. These requirements are appropriately defined and documented by the sub-task groups, and include specific quality assurance requirements.

These requirements are verified, prior to placing orders with suppliers and appear in the **List of Accepted Suppliers** established and maintained, at all times, by the sub-task group, and made available for review to the Task-leader, and the Projetc management group.

The **List of acceptable suppliers** shows, for each supplier, the list of items, services or item families for which it has been approved and the degree of criticality of these items or services (CC, SC or NC). Each supplier is identified on the basis of the highest item criticality supplied. The **List of acceptable suppliers** also records the level of quality verification to which the supplier is submitted as shown on the table below :

SUPPLIER' S NAME / Adress	Price negociated	Cost analysis available	Financial history rev'd	Staff (number)	Organisation Chart supplied	QA Manual available	QA Certifed	Traceability verfied	Statistical meth.verified
Authorized contact	ALL	CC, SC	CC, SC	ALL	ALL	CC, some SC	CC or QA manual	CC, SC	CC, most SC
CC (list) / SC (list)	Burn in & test eq. Avail.	CPFME done on product	PAO audits permitted	Initial QA audit done	Capacity vs/ load verified	Other source for product	No reject recorded	Few rejects recorded	Freq. rejects recorded
NC (list)	CC/SC if applicable	CC	ALL	CC, some SC	ALL	ALL	ALL	ALL	ALL

7.4.2. Purchasing information

Each Sub-task Group is responsible for ensuring the integrity of their purchasing data and documents. This means that purchasing documents clearly describe the deliverables that are expected from the suppliers (such as data, parts, service, etc.). As applicable, the description includes or references a part number, specification, and/or drawing, as well as any other requirements that have been defined by the Task Group or the Sub-task Group.

For CC and SC items or service, alla acceptance criteria, including those referring to packing, shipment, lanelling and traceability records is determined in writing as a part of the contract or purchase order with the supplier.

Purchase histroy is kept available as a Quality Record by each sub-task group and can be made available to the Task Leader when requested. It is kept in such a way, that all CC and SC items or services can be identified and linked to their original purchase, test and delivery.

Purchasing information to suppliers must mention clearly the specific envirnmental conditions under which their products will have to be transported, stored, installed and operated.

Particularly, it must specify :

- that the life time of the experiment (life time) is 20 years.
- that a continuous operation is required for this period.
- that the failure analysis is performed with an expected MTBF (Mean Time Between Failure) of 10^6 hours (use of MIL-HDBK-217F tables for ground fixed experiments is recommended when applicable).
- that transportation conditions require acceptance of accelerations as high as 10 x gravity
- that the temperature variation ranges from –20°C to +70°C.
- that the product will be under environmental conditions with high humidity (30-70%), condensation and salinity.

7.4.3. Purchased material, equipment and service acceptance

Each Task Group is responsible for ensuring that procured items or services comply with their requirements.

Compliance verification can be done by incoming inspection and testing, verifcation of test records received from the supplier or testing at the supplier's site. In all cases, proof of verification must be kept by the sub-task group and made available to the Task or project management when required.

Supplied items or services are accepted only after verification of identification and traceability information. This information must include :

- Identification of the supplier
- Identification of the sub-task organization's order or contract
- Identification of the part
- Identification of the component lot (if applicable)
- Identification of the fabrication batch (if applicable and different of lot)
- Date of manufacture
- Burning profile (if applicable)
- Conditions for functionality tests (if applicable)
- Test results
- Name or identification of the person who performed the test
- Comments on inspection (if any)

7.5. PRODUCTION, INSTALLATION AND SERVICE

7.5.1. Process control

The overall production process devoted to the SDE Task group is decribed by the diagram in § 7.1 (General Process Mapping) of this QMP. It includes, for the items produced, production, installation and maintenance activities. It complies with the PAO general policy as expressed in the **Pierre Auger Observatory Quality Assurance Plan**.

The SDE task is separated into sub-tasks or individual processes. Each sub-task, as shown, is divided into sub-processes. Each sub process is intended to produce one item (or several items of similar technologies) and belongs to one organization particpating to the sub-task.

Sub-task leaders are in charge of identifying the most appropriate person as sub process manager. Each sub process manager, under control of the sub-task leader, established the sub-process **Operation Procedure** using the **Operation Procedure Template**.

The **Operation Procedure Template** contains all basic information suggested by the **Pierre Auger Observatory Quality Assurance Plan** as part of the "Traveler", "Flowcharting" and "Control planning".

Based on **Operation Procedures** , each sub-task leader determines what form, records can be established and kept available, to show that the process described has been correctly followed. Such records fulfil the requirements assigned to the Traveler for traceability.

For the SDE task group, process control includes maintenance requirements, which are expressed, at the sub-task level in the **Sub-task Maintenance Plan**.

These plans are established following the **PAO Maintenance Plan Template**. They include maintenance documentation, spare part lists (type and quantities to be kept on the site) and failure diagnostic tips. They are made available by the SDE Task Leader to the Site Mananger and used to establish the **Site Management Plans**.

It is the responsibility of the Site Manager to:

- organize a servicing/maintenance program for the Observatory using the **Site Management Plans**;
- implement the servicing/maintenance program for the Observatory; and
- ensure that the site personnel receive the appropriate training on the program.

The **Project Management Plan** contains more details regarding the **Site Management Plan**.

7.5.2. Process validation

Operation procedures are established by the sub process manager and validated after review by the Sub-task manager and, if appropriate, the subsequent (i.e. "customer") sub-process managers.

7.5.3. Product identification, labelling and traceability

The SDE task group has established, at the Sub-task level a tproduct traceability system which complies with the PAO general policy as expressed in the **Pierre Auger Observatory Quality Assurance Plan** and the **Conventions for the Pierre Auger Observatory.**

Sub task Leaders are responsible for developing and implementing a system to record and track batch, lot, and serial numbers for parts/components that are used to make the detectors. The information recorded also includes inspection and test results.

This system should be planned and implemented with the goal of easily being able to trace a detector's history.

Each operation procedure determines records to be kept of individual process operations. These records are kept under the responsibility of each-sub task leader. At the Sub-task level, Traveler records are being established and recorded in the "**Traveler Data Base**", maintained and updated by the PAO Quality manager.

The information to be recorded, at the sub-task operation level includes, for each part supplied :

- Identification of the part following the document **Convention for the Pierre Auger Observatory**
- Identification of the component lot
- Identification of the fabrication batch
- Date of fabrication
- Burning profile
- Conditions for functionality tests
- Test results
- Name or identification of the person who performed the test
- Comments on inspection or production aprticulars

7.5.4. Cross task product care

When receiving, incoporating, handling or storing parts or sub-assemblies which are included in other Task or sub-task group, sub-task leaders are in charge of maintaining proper identification, labelling, packaging storing and general preservation as if the part or sub-assembly was their own. This implies that any incident to these parts or sub-assemblies or any event that may impair their functions must be reported to the task or sub task group in charge of producing the particular part or subassembly.

7.5.5. Handling, shipment, packaging and storage

A special care should be taken in defining packaging which can prevent the part from damage and deterioration during the transportation by air and by ground in difficult conditions (large temperature variations, pressure variations, humidity, rough handling etc.).

Due to a fabrication process of the SD Electronics in which different parts are fabricated in different places and shipping is done several times during the process, the packaging should be designed in a way that it can be used , if possible, for the whole fabrication process and also for the storage.

Shipping and storage are tracked and fed into the "Traveler data base".

A plan for handling and storage is defined by the SDE Task Leaders together with the Site Manager.

For international shipment, all documents related to customs operations are kept and updated in the contry of arrival. These documents as well as appropriate forms to be used are made available to sub-task groups that have to ship towards the country destination.

7.6. CONTROL OF TESTING AND MEASUREMENT DEVICES

Measurements are performed to test or verify throughout all production processes of the Surface Detector Electronics.

These measurements are performed, at each sub-process level, with measuring devices, equipment or refernces that are listed in each **Operation Procedure**.

In order to comply with the policy as expressed in the **Pierre Auger Observatory Quality Assurance Plan** each measurement device, used for PAO production, that can affect product quality, is verified to insure that :

- The device is consistent in accuracy and precision with the intended tests.
- The device is calibrated at intervals not to exceed one year or be longer than the manufacturers recommendations or other prescribed time using documented methods.
- Calibration is performed against aceptable references including, if required, official national standards.
- Environmental conditions are suitable for the tests being carried out.
- Identifying test equipment calibration status appropriately.
- Handling, preservation, and storage of test equipment is such that the accuracy and fitness for use is maintained. This includes preventing adjustments to test equipment that would invalidate the calibration setting.

Records of measuring equipment status is kept near the equipment and always includes :

- Measuring equipment manufacturer's technical documentation (user's manual, service manual, calibration recommendations), including recommendations for environmental and handling conditions.
- A record calibration or verification status showing clearly when and by whom the next calibration should be performed.

IMPORTANT : Measurements performed after the calibration date recorded with the equipment or when calibration shows a past drift higher than the product acceptance tolerances have to be considered and reported as Non Conformities (see § 8.3).

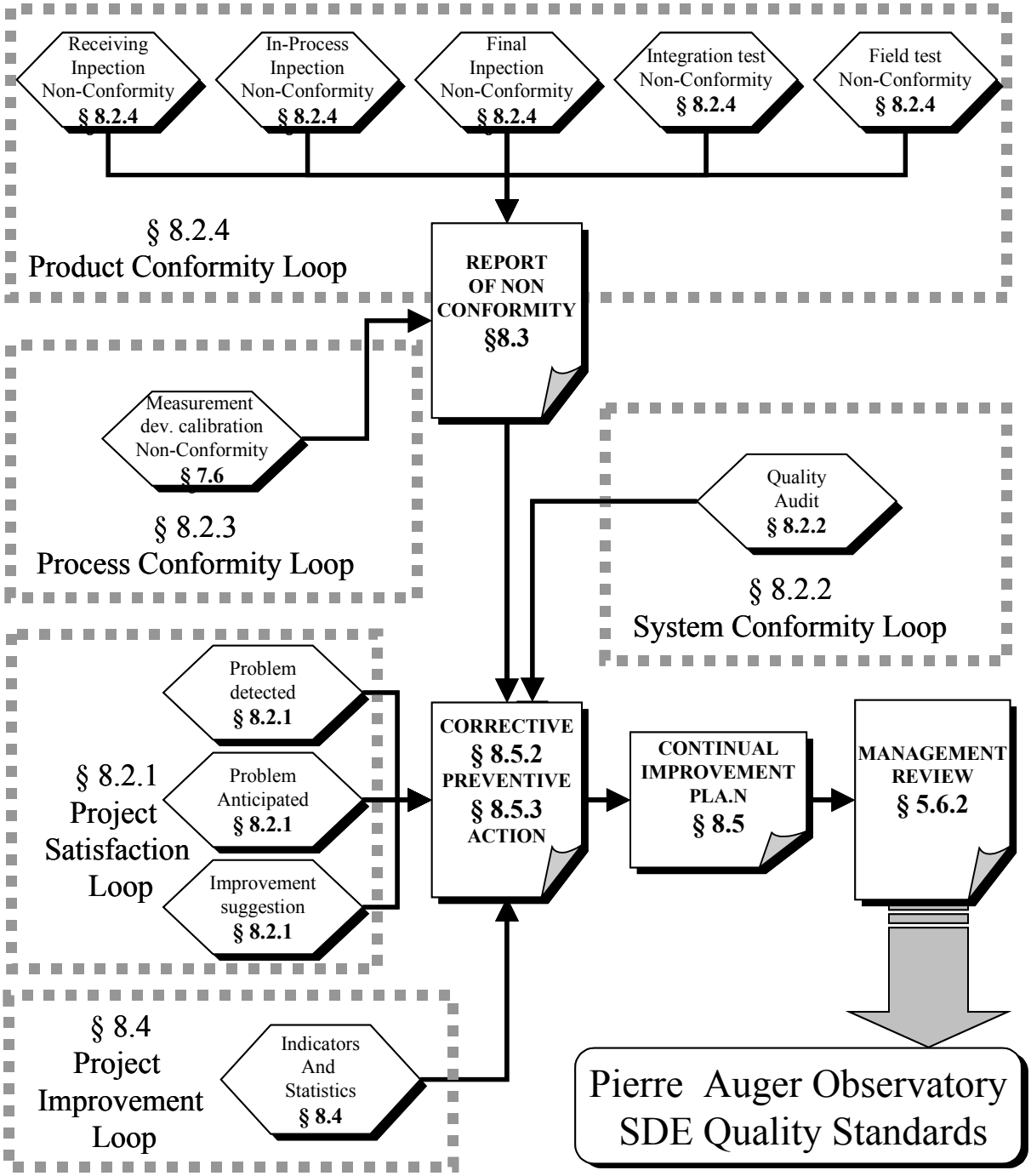
When measurements are required with SDE Task products, within the **Site Management Plans**, measurement devices have to be available on the Site and calibrated under the same conditions as specified for initial testing.

Maintenance of measurement devices on the site are placed under responsibility od the Site Manager.

8. QUALITY IMPROVEMENT SYSTEM

8.1. GENERAL DESRIPTION OF THE QUALITY IMPROVEMENT SYSTEM

This diagram presents the articulation of the SDE Continual Improvement System :



8.2. INSPECTION AND TESTING

8.2.1. Project satisfaction

Assessment of the overall PAO project satisfaction is obtained using all means of communications available between the groups : meetings, www, e-mail, notes etc…

When a problem is identified, which impairs the ability of the Project to reach its goals, even if not implying a non-conformity, the description of the problem is transmitted to the SDE Task Quality Correspondant who opens a Corrective Action (see § 8.5.2).

When a problem is anticipated, which might, if it occurs, impair the ability of the Project to reach its goals, the description of the possible problem is transmitted to the SDE Task Quality Correspondant who opens a Preventive Action (see § 8.5.3).

When a suggestion is proposed, to decrease the risks for the Project not to reach its goals, the description of the proposal is transmitted to the SDE Task Quality Correspondant who opens a Preventive Action (see § 8.5.3).

8.2.2. Internal quality audits

Quality audits are organized with each sub-task group to verify that the provisions of this **Quality Management Plan** are well unserstood and applied.

These audits are performed according to the **SDE Quality Audit Procedure**, by qualified auditors, based on a program determined by the SDE Task leader.

Conclusions of these audits are kept as quality records and lead to corrective (§ 8.5.2) or preventive (§ 8.5.3) actions.

8.2.3. Assessment of process quality

Assessment of process quality is done at the SDE task group level and sub-task group level by reviewing the information recorded in the "**Travelers**". Whenever differences appear between the recorded information and the **Operation Procedures**, a report of process Non-Conformity is issued (see § 8.3).

It is particularly the cas when test or measurements appear to have benne performed on a device which was out of calibartion (see § 7.6)

8.2.4. Assessment of product quality

The policy of the SDE Task is to ensure that all items, components, and services meet the technical specifications. This is verified through inspection and testing. In the case of SD Electronics, systematic inspection and testing and sampling testing is performed in various stages of the fabrication, shipping and installation. In addition to this, a systematic burning is required in order to avoid infant failure of electronic circuits.

A detailed test plan is presented in the **SDE Test Plan** document for different subsystems of the SD Electronics. This plan is following the procedure described below.

Subtask Leaders are responsible for defining the Test Plan for their subsystem. The results of different tests should be documented as ruality records and kept available for traceability.

8.2.4.1. Receiving Inspection

A receiving inspection is performed for all incoming products at each sub-task level as indicated in **Operation Procedures**. This inspection includes a physical verification, simple functional test with a specified test equipment when applicable and review of suppliers' final test records and inspection.

Before the deployment of the electronics on site, a receiving inspection is performed in Malargue. This inspection should be well documented and highly automatic to allow for non-speciallized personnel to perform the inspection after a short training, record the results and if necessary, take correcting action.

8.2.4.2. In-Process Inspection

In-process inspections for SDE are performed during the fabrication process as indicated in **Operation Procedures**.

These inspections are the functionality tests performed after fabrication of different parts of the electronics. In-process product is not processed further until it has been inspected or otherwise verified as conforming to technical specifications.

8.2.4.3. Burn-in

A systematic burn-in of different electronic parts is performed as indicated in **Operation Procedures**. If a supplier is used, this is mentioned in the technical specifications.

The aim of the burn-in is to reduce infant failures and simulate the system life cycle.

Unless otherwise specified, burn-in for electronic sub-assemblies requires functioning at a high temperature (> 70°C) for a minimum of 48 hours.

8.2.4.4. H.A.L.T.

The aim of the Highly Accelerated Lifetime Testing (HALT) is to test the long term reliability. This test can be performed by sampling, by lot, after manufacturing. It consists typically of a burn-in of electronic circuit while it is functioning at about 70°C during 7 days, which corresponds to a lifetime of about 10 years.

8.2.4.5. Functionality test

A functionality test is performed systematically after fabrication as indicated in **Operation Procedures**.

If a supplier is used, this test can be performed by the subcontractor following the test plan established by the Subtask Group and using a test equipment specified by the Subtask Group (see **SDE Test Plan**).

If the supplier is responsible for the functionality tests, the Subtask Group should perform sampling testing during the fabrication process in order to control the quality of the fabrication process.

8.2.4.6. H.A.S.S.

The Highly Accelerated Stress Screening (HASS) is performed systematically after fabrication as indicated in **Operation Procedures**.

This test includes rapid temperature cycling and voltage stresses (power on/off).

For the SD Elecronics the vibration and humidity stress (normally included in the HASS) may not be necessary when the array is ground based and not subject to vibration (except during the transportation) provided that all electronic parts are coated against humidity.

The HASS can typically be combined with the functionality test.

8.2.4.7. Final Inspection

Final product is not shipped until it has been inspected or otherwise verified as conforming to technical specifications.

Final inspection includes the confirmation that all receiving and in-process inspections have been completed, and that the results meet the technical specifications. In particular, concerning the SD Electronics the final inspection should make sure that

- Burn-in
- Fontionality test
- HALT by sampling
- HASS

as described above, have been performed and documented.

8.2.4.8. Integration tests

The different parts of the SD Electronics will be integrated in Argentina (La Plata). A final integration test should be performed before shipping to the site.

This test should validate the functionality of the whole electronics, except for the PMT electronics which will be shipped directly to the site after the final inspection. The PMT – station electronics integration test will be performed after mounting the PMTs and the station electronics on the tank, prior to the deployment of the tank in the field. This test can be performed by using the LED flashers mounted on the tank liner.

8.2.4.9. Field tests

After deployment of the tank with its electronics to the field, a short functionality test should be performed. This test can be performed by using the LED flashers and should validate the transportation to the field.

8.2.4.10. Positive Recall

When product is released for urgent production use prior to verification, it is positively identified so as to permit immediate recall if necessary (this is termed "positive recall"). The Task Leaders are responsible for determining when the use of unverified product requires approval by review of the Configuration Control Board.

8.3. CONTROL OF NON-CONFORMITIES

It is the policy of the Auger Project to control nonconforming product such that it is not inadvertently used in the fabrication of the detectors. The SD Electronics Task follows this policy.

Non-conforming products are identified at any inspection on test, and at all sategs. A non-conformity is identified every time :

- a product or service does not meet predetermined acceptance limits as expressed in technical documents,
- a product or service has reached a stage of production without traceability of previous inspections or tests,
- a product has been manufactured or tested on a device where apprpriate maintenance or calibration, at time of test, cannot be proven.

When a non conformity is identified, it is reported, using the template "**Report of non-conformity**" according to the **Procedure For Non Conformity Control**. It is clearly identified as non-conforming ans a copy of the **Report of non-conformity** is kept attached to it, in order to avoid its use by mistake.

The **Procedure For Non Conformity Control** indicates how the non-conformity is handled towards a decision which may be :

- return to supplier (internal task group on vendor),
- on site repair,
- accept as is,
- other (including reject and replace, modify…etc)

The decision is taken based on the following situations :

- The criticality of the characteristic(s) of the part that is out of specification or that of the part itself (CC, SC or NC)
- How far the part is out of specification
- The potential risk of failure of the detector subsystem due to the nonconforming part
- The effect of the nonconforming part on other detector subsystems
- The effect of the nonconforming part on the science objectives

When nonconforming product is accepted as is, and is used in the manufacturing of the detectors, then the Task Leaders are responsible for notifying the Systems Engineer of the situation with a copy of the **Report of non-conformity**. This communication allows the Systems Engineer to notify other Task Leaders that may potentially be affected by the nonconforming product. The Task Leaders are also responsible for determining when the use of nonconforming product requires the review of the Configuration Control Board.

8.4. DATA ANALYSIS AND STATISTICAL TECHNIQUES

Statistical techniques and visual display of statistical analysis are used by the SDE task group to measure quality and performance in four cases :

a) **To evaluate project satisfaction (see § 8.2.1)**
expression, by other Task groups or the PAO management of problems detected, problems anticipated or positive improvement suggestions are tracked and synthesized using the **Corrective Action procedure** or the **Preventive Action procedure** to produce a Project Satisfaction Indicator showing the evolution, in time, of correction and improvement requests. The definition of this indicator is given by the **Project Satisfaction Indicator Sheet**.

b) **Every time sample testing is used to qualify the product or a lot thereof,**
the sampling method is justified in writing and available for audit or review.
It is recommended that this justification be done using a standardized statistical method applicable within the sub-task groups and the external suppliers.

c) **To evaluate the efficiency of the continual improvement system (see § 8.5.1),**
All actions resulting of the improvement system and reported in either the **Corrective Action procedure** or the **Preventive Action procedure** are summarized to supply an Improvement Dynamism Indicator. The definition of this indicator is given by the **Improvement Dynamism Indicator Sheet**.

d) **To evaluate external suppliers,**
An indicator of supplier non-conformity rates is established and maintained by each sub-task group for critical items supplied (CC items as defined in § 7.4.1).
The definition of this indicator is given by the **Critical Supplier Non Conformity Rate**.

8.5. IMPROVEMENT PLAN

8.5.1. Continual improvement plan

In order to comply with the recommendations for project improvement expressed in the **Pierre Auger Observatory Quality Assurance Plan**, the SDE Task group uses a continual improvement plan as described on the diagram above (§ 8.1).

This plan is based on the **Continual Improvement Plan template** and used as a follow-up tool for all corrective and preventive actions decided to maintain and improve SDE quality.

It is maintained by the SDE task Quality correspondent and kept avilable for the SDE task leader review.

It produces two indicators which are published to the Project on a regular basis :

- the Project Satisfaction Indicator, and
- the Improvement Dynamism Indicator

It is one of the elements submitted for SDE Quality Management Reviews (see § 5.6.2).

8.5.2. Corrective action control

Corrective actions are implemented in the following cases :

- repeated product non-conformities or repetition risk for non conformities reported according to the **Procedure For Non Conformity Control** and identified at any stage of production, installation or maintenance testing (§ 8.2.4),
- repeated process non-conformities or repetition risk for non conformities reported after “traveler” review against **Operation procedures** (§ 8.2.3), including measurement device calibration non-conformities (§ 7.6),
- problem detected by other Task groups or PAO management that has a negative effect on the overall Project quality (§ 8.2.1),
- quality system non compliance detected while auditing the SDE task or a sub-task operations (§ 8.2.2),
- situation where any of the quality system indicators reaches or exceeds its non acceptance limit (§ 8.4)

Corrective actions are reported using the **Corrective / Preventive Action Report** template according to the **Corrective Action Control Procedure**.

8.5.3. Preventive action control

Preventive actions are implemented in the following cases :

- potential problem detected by other Task groups or PAO management that might have a negative effect on the overall Project quality (§ 8.2.1),
- suggestions for improvement made by SDE task group, other Task groups or PAO management that might have a positive effect on the overall Project quality (§ 8.2.1),
- quality system drift detected while auditing the SDE task or a sub-task operations which might lead to a system non compliance (§ 8.2.2),
- situation where any of the quality system indicators varies towards its acceptable limits (§ 8.4)

Preventive actions are reported using the **Corrective / Preventive Action Report** template according to the **Preventive Action Control Procedure**.