

# Zero Defect Methodology: Is the GaAs Industry Ready?

Authors: Jan Campbell

Freescale Semiconductor CS1 Fab

2100 E. Elliot Road, MD EL609, Tempe, Arizona 85284

[JanCampbell@Freescale.com](mailto:JanCampbell@Freescale.com) 480-413-7427

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## Abstract

**The foundation for any quality system must be solid and secure. If a company does not have a strong foundation it will find itself constantly fighting quality issues. Automotive manufacturers have long demanded that their suppliers strive for zero defects in parts that they produce (Industrial Weekly, Oct 2003).**

**The reason is clear: sensors that fail in airbags, brakes and other components can cause loss of life. However, the consumer market has not yet embraced the zero defect concept, but many final users are now demanding that the parts they purchase are free of defects.**

**“Zero Defects” was originally introduced by Crosby and first used in the automotive industry. One of the major foundations of a Zero Defect program are the 5’S” (Seiri, Seiton, Seiso, Seiketsu, Shitsuke), which has been used in Japan for sometime and recently introduced to the American Semiconductor industry. This paper will present one approach to introduce these methodologies to a semiconductor manufacturing facility. Together these two proven approaches to quality will ultimately change the way we do business.**

## INTRODUCTION

It is the responsibility of the final manufacturer and supplier to provide defect-free parts. This additional requirement is not without cost: adding inspection steps is an ongoing issue for a semiconductor manufacturer. As fabrication facilities work to reduce prices by improving the efficiency of their manufacturing processes, their inspection costs have risen dramatically (Hands, 2004) Historically, these manufacturers have focused on the production side of manufacturing parts, with inspection as an afterthought. Now, because of the quality demands placed on them, quality and defectivity groups must inspect out defective parts. These additional inspection or sorting methods have created new variables for the manufacturer, including cost, time, and more often than not, an inferior inspection process. Although customers recognize the added cost associated with the inspection of the manufacturer’s product, they aren’t willing to pay higher prices to reduce the fab’s defects per million (PPM) levels. Regardless, the expectations from the customers still remain at “Zero PPM levels.” And, in most cases, fabs have had to incur the inspection cost. This leads to an improved solution: building quality in and not

inspecting it out. There must be a clear methodology that is associated with eliminating these defects.

Although no organization will deliberately pass defective components on to their customers, it is extremely important that there is a clear goal to reach zero defects and to prevent these defective parts from leaving the factories. As more and more applications for GaAs chips and chipsets are found, the likelihood of these parts finding their way into critical applications becomes more probable and a zero defect methodology approach to manufacturing these parts is needed.

Establishing a foundation for Zero Defects is needed, one approach is the Five S System (5’S) originally presented by Hiroyuki Hirano in 1990.

This next section will look at how a 5’ S system can be applied to a Gallium Arsenide Facility (Compound Semiconductor Fab One (CS1) and the results of such activities.

## THE FIVE S SYSTEM

On initial investigation the 5’S system seems too simple; on the surface it seems that it cannot possibly add much value, in addition it’s just about being neat and clean. So, why should you introduce it your company? After all, we have so many other systems we have to maintain. It is exactly this point; the beauty and strength lay is its simplicity. Often, more then not, we are the victims of our own demise; we introduce complex quality systems, hire consultants and pay exorbitant fees, and then never introduce or maintain these systems. Any system that is introduced as a foundation for a quality system must be simple, relatively easy to understand and easy to implement. However, managing the culture change to an organization can be complex and difficult. Management must be bought into the fact that it adds value.

The 5s system is a series of activities designed to improve workplace organization and standardization. These include:

1. Seiri – Sort, keep only what is absolutely necessary, get rid of things that you don’t need, i.e. simplify.
2. Seiton - create a location for everything, i.e. organize
3. Seiso - clean everything and keep it clean, i.e. cleanliness
4. Seiketsu - implement Seiri, Seiton and Seiso plant wide, i.e. standardize

5. Shitsuke - assure that everyone continues to follow the rules of 5S, i.e. stick to it.

Seiri (整理) / Sort and Simplify

Seiri is the process for sorting out what items are required and which are not in normal operation: a) Is it essential for daily operations? b) Does it have to be in the clean room? c) review where to store if not used for 6 months. d) Discard if not used for 12 months. This stage (Sort) may need to be done periodically. One tool used at CS1 is the Zone Defense Team, which does a weekly audit. This team is also part of the Zero Defect Team which organizes weekly fab cleanups. This weekly audits are performed by Zero Defect team members to identify:

1. All visible degradation in the clean room facilities.
2. Foreign material.
3. Abnormalities.

In figure one: CS1 Zone Defense yearly incidents are depicted. The top 10 findings have to be fixed before the following audit.

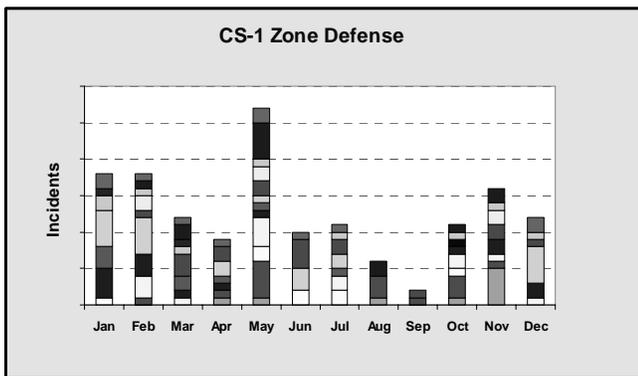


Figure One: CS1 Zone Defense

Seiton (整頓) / Set in Order

“Seiton” or orderliness, is all about efficiency. This step consists of putting everything in an assigned place so that it can be accessed or retrieved quickly, as well as returned in that same place quickly... Every single item must be allocated its own place for safekeeping, and each location must be labeled for easy identification of what it's for.” An example of a work area is shown in figure two: ACI Layout

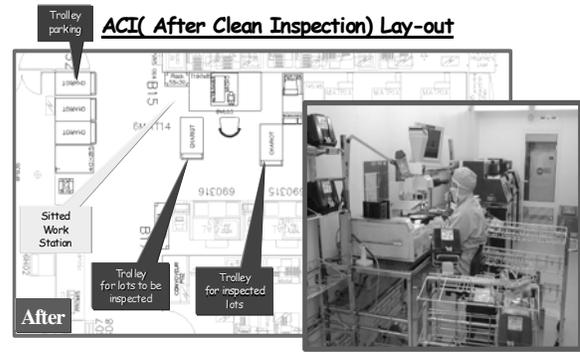


Figure Two: ACI Layout

Seiso (清掃) / Shine

“Seiso, the third step in 5’S, says that everyone is a janitor.” Seiso consists of cleaning up the workplace and giving it a 'shine'. Cleaning must be done by everyone in the organization, from operators to managers. Everyone should see the “workplace” through the eyes of a visitor - always thinking if it is clean enough to make a good impression...” Introduction to a weekly cleanup is essential in keeping defect awareness at CS1. Based on a sister fabrication facility, CS1 has introduced a “HEURE SOLEIL” or sunny hour, where once per week, production is stopped during a 60 minute period and all personnel including CS1 staff participate in the cleaning of the fab, using a specific check list. An example of participation is displayed in figure three: Fab Participation

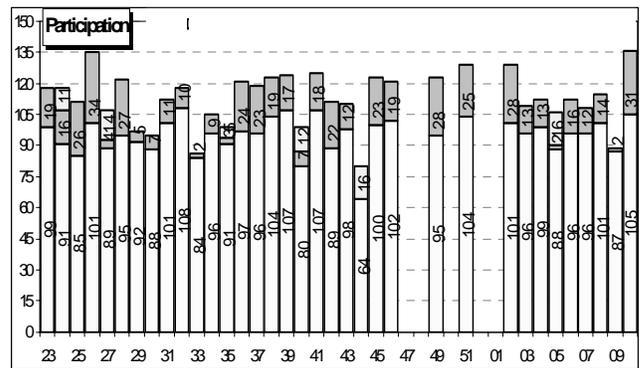


Figure Three: Fab Participation

Seiketsu (清潔) / Standardize

“Seiketsu” is maintaining and improving cleanliness. Define the standards that need to be kept and put a process in place to ensure that your standards don’t drop. You need to complete Seiri, Seiton, and Seiso (sort, set in order, and shine) before moving on to this step. It sets the standards required which are supported by regular check, etc.)

Shitsuke (躰) / Sustain

“The last step of 5’S, Shitsuke, means 'Discipline.' It denotes commitment to maintain orderliness and to practice the first 4 S as a way of life. The emphasis of shitsuke is elimination of bad habits and constant practice of good ones. Once true shitsuke is achieved, personnel voluntarily observe cleanliness and orderliness at all times, without having to be reminded by management.”

Further CS1 has implemented sustaining activities such as

1. Management Commitment
  - a) Foreign Material Audit Patrol
  - b) Sunny Hour
  - c) Error Free
  - d) Recommendations
2. Continuous improvement
3. Training
4. Control & measurement of class 10 environment
  - a) Particles according ISO Standards
  - b) Witness wafers
  - c) Deposition rate: amount of particles deposited on a test wafer, permanent deposition test wafers, audit deposition test wafers
  - d) Delta of pressure
  - e) Laminar air flow
  - f) Room filters
  - g) Temperature and hygrometry
  - h) Out of control situation
  - i) Equipments are controlled using SPC rules

**RESULTS**

Implementing such a system must show clear results: there are several measurements that CS1 uses to measure the success of implementing a defect reduction program. In figure four, final outgoing inspection (FOI), defect awareness has contributed significantly at CS1 to an increase in FOI yield.

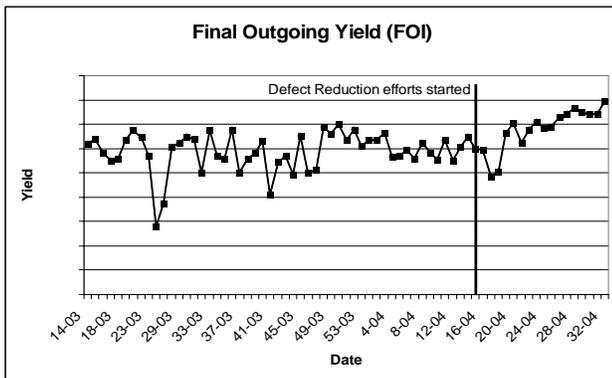


Figure Four: Final Outgoing Inspection (FOI),

Further, proof of defect awareness and the decrease of defects seen on wafers, is monitored using an automated defect on wafer (DOW). Defects are measured on wafers and monitored per process, tool, area as well as group. This provides clear direction for action items to be driven on a weekly basis. An example of CS1’s DOW charting is depicted in figure five, CS-1 Defect DOW.

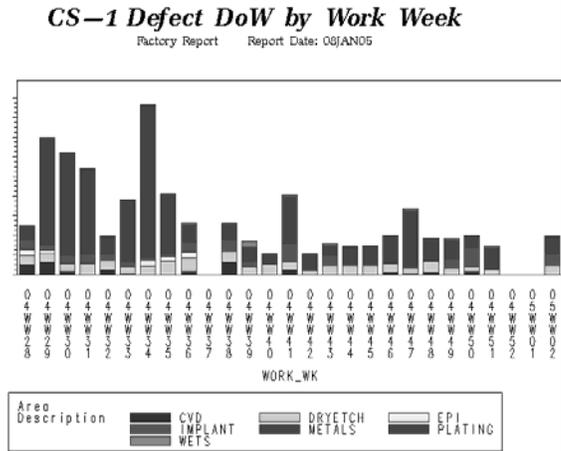


Figure Five: CS-1 Defect DOW.

Probably the most important component of a “Zero Defect” is what escapes to the customer and ultimately be a customer return. This is a very important gauge in determining if your factory is truly moving towards zero defects. CS1 uses a customer quality incident report (CQI) This report includes assembly site requests for corrective action, customer returns as well as any internal or external requests for escapes. CS1’s customer quality report in given in figure seven, customer quality incident reports (CQI). CS1’s CQI report is presented in figure six, CS1 customer quality incidents (CQI).

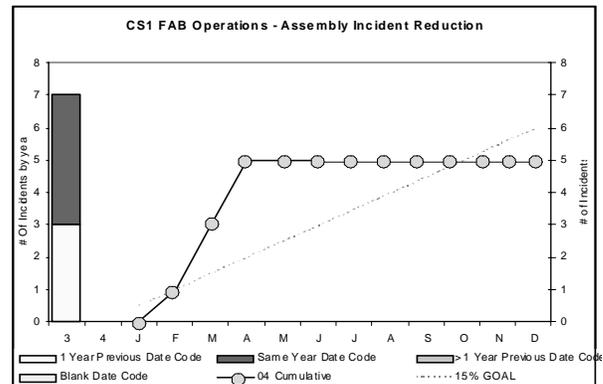


Figure Six: CS1 customer quality incidents (CQI).

## CONCLUSIONS

A “Zero Defect” methodology incorporates establishing a foundation which maintains and monitors defects in a factory. Defect reduction activities are everyone’s responsibility. It is a culture change that must be supported at all levels.

Since implementing a “zero defect” methodology, significant improvements have been obtained in the reducing customer quality incidents and increasing final outgoing yield.

### Acknowledgements

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### ACRONYMS