1. **Scope of Supply**
   Defect detection in production process of glass bottles.

2. **Basic Data Provided by Customer**
   Glass Bottles: - our study has been developed on samples supplied by Client:
   - Format A bottle: $\text{Ø}_{\text{ext}} = 26 \text{ mm}, H = 58 \text{ mm}$
   - Format B bottle: $\text{Ø}_{\text{ext}} = 52 \text{ mm}, H = 94 \text{ mm}$
   Maximum Productivity: - max 230 bottles/min

3. **Name of the System Proposed**
   "QualiGlass"

4. **General Working Principle of the System**
   Our solution is based on 2 groups of 6 cameras and a special back-lighting system. The first group looks at the upper half (top half) of the bottle, the other observes the lower half (bottom half) (see fig. 1). Cameras of each group are angularly disposed to observe the whole sidewall surface of the bottle. This configuration has been studied to obtain high resolution images with an optimal contrast in order to detect all the typical defects of glass bottle.
Each group of 6 cameras is placed as in fig. 2, with camera spaced ~ 60° each other, thus providing an overall 360° view of the bottle. The difference between the two group of cameras is only in height respect to the conveyor belt surface (to observe an enlarged image either of the top half or of the bottom half of the bottle). If just one of the cameras detects a defect that exceeds the set tolerance values, the bottle is removed from the belt, with a special reject unit.

It's possible to install our vision machine on existing conveyor, with the following characteristics:
Transport of Bottle: To ensure proper controls, bottles must be spaced at a distance of 60-70 mm. The transportation system must be designed to avoid or limit to a very minimum bottles vibration and/or oscillations.

Colour of conveyor belt: Dark black, not reflecting

5. **INSPECTION OPERATED BY THE SYSTEM**

According to cameras configuration described above, Fig. 2, and with the special back-lighting system it is possible to detect the typical defects in production process of glass bottles (incomplete finish, sidewall and finish cracks, sidewall scratches and deformations, sidewall blisters and inclusions, ...).

A report of the acquired pictures of the two different format samples provided by customer is presented below

Format A bottle pictures:
On almost all the supplied samples are visible some "signs" that, according to our experience, are not real flaws but are caused by the glass production process. In this picture is shown one example.
6. SYSTEM INNOVATING FEATURES

The QualiGlass result from many years experience and studies in the bottle sector. This allow Falcon Instruments to present a system capable to resolve problems of detection on bottles at very high production rate. Below some important issues are outlined.

6.1 FAST CHANGE OF PARAMETERS ON PRODUCTION CHANGE.

The high resolution 8 bit CCD camera, s/r > 60 dB, is diaphragmed by PC without any manual intervention. Once the proper value in the calibration phase has been recorded, nothing else to do but recalling the relevant file on change production and the Systems is automatically reconfigured. For change of bottle with different height, it’s possible to move a top camera in the new position, thanks to a micrometric slide unit.
6.2 EASENESS OF USE.
The very simple software customized for bottles control allows very fast and intuitive calibration. Parameters are protected by password and the relevant management is reduced to the variables actually in use and displayed on screen.
It is also possible to display only the page summarizing statistical data or to associate to this the image relevant to the last rejected piece.
The algorithms of the software are proprietary and developed for bottles control.

6.3 SPREADSHEETS.
The software allows to manage spreadsheets, job code, product code, operator name, start date of activity, job suspension, job end, machine stops and relevant causes, number of pieces produced, pieces rejected, etc, transferable via network to the customer Quality Control or Production computer to create typical electronic reports.

7. BASIC ELEMENTS COMPOSING THE SUPPLY
These are Acquisition Unit, Processing Unit, Feeding Unit, Software Package.

**Acquisition Unit** installed on the conveyor belt where the bottles are already spaced and composed of:
- N°. 12 CCD monochromatic high resolution and speed camera, with professional lens. These have the possibility of remotely managing the shutter speed, to change image brilliance on the basis of bottle transparence;
- Dedicated lighting system, (with relevant powering unit), whose shape and dimensions is designed so as to stand interesting details out on lateral.

**Processing Unit** contained inside industrial cabinet and composed of:
- Falcon P4 Platform, equipped with 17" LCD monitor touch screen, mouse and keyboard.
- Supervisory unit (micro PLC), interfaced to the Processing Unit form which it gets the result of control and by sensors, manage rejection, pieces counting and package change;
- 8 protected I/O interfacing unit logic NPN/PNP placed between Processing Unit, Supervisory Unit.

Besides, the hardware is completed with:
- sensor of presence in the control area, to synchronize image acquisition when bottles are positioned at the center of cameras FOV;
- sensor of presence in the rejection area;
- actuator for rejection of defective pieces, composed of electrovalve operated by the Supervisory Unit.

**Software Package** operating in Windows XP environment and processing the images coming from cameras. The current image of the object is digitalized and instantly compared to a reference image, recorded during the calibration phase. On the basis of the tolerances established by customer, the object is rejected or considered in compliance.
The result of the control is communicated via I/O Unit to the mini-PLC, managing the rejection of defective pieces and their counting. The interface machine-operator is very easy to use. The operator has the access to all functions by touch screen, keys or mouse.

8. ELEMENTS ADDITIONAL TO THE SUPPLY
The Supply is also inclusive of the parts listed below and additional to the:

**Processing Unit:**
- customized rack for electronics completed with
  - internal cabling
  - air forced ventilator group
  - main switch
  - connecting cable from Processing to Acquisition Unit
- customized rack for electronics completed with
  - internal cabling
  - air forced ventilator group

**Acquisition Unit:** Mechanical container for lighting system and cameras, customized for the specific application.
The belt and the mechanical unit to transport and orient the bottle isn’t included in the present offer, but we remain at your disposal to propose our dedicated mechanical unit.