19.1 Introduction

In order to have an effective quality control programme, we need a well-equipped quality control laboratory where we have to analyze the various materials, such as raw materials, semi-finished, finished, stored products etc. for various chemical and bacteriological parameters, so as to see that they meet the legal and quality standards.

Therefore, quality control laboratory should be regarded as one of the key features of any dairy plant. While designing a dairy plant, a due consideration should be given for the location and design of a quality control laboratory.

According to BIS, 5 categories (types) of laboratories have been suggested or recommended depending upon the quantity of milk handled by each dairy. However, these are recommendations only; one can make modifications in them to suit the requirements of a particular plant.

19.1.1 Types of dairy laboratories

1) Category A
   For dairies which handle 1 lakh liters or more of milk per day.
2) Category B
   For dairies which handle 25,000 litres or more of milk per day, but less than 1 lakh litres.
3) Category C
   For dairies which handle 10,000 liters of milk or more per day, but less than 25,000 liters.
4) Category D
   For dairies which handle 5,000 liters of milk or more per day, but less than 10,000 liters.
5) Category E
   For dairies which handle less than 5,000 liters per day.

i) For the first three categories more or less similar facilities are required. The facilities are as follows:

   *Bacteriological room, sterilization and Media room, balance room, wash-up room, gas chamber, fume chamber (Fume hood or fume cupboard), Fine instrument room*, Separate rooms for *quality control officer and laboratory staff, working benches* etc.
ii) For last two categories, fewer facilities are recommended. For example, Bacteriological room, Sterilization & Media room, fine instrument room are not generally required. These labs look like labs only for collection centers.

19.1.2 Location of QC lab in a dairy

Some important points for location are

1) It should not be at a remote (far-off) place from the dairy operations because procurement of samples or conveying of results should not take unnecessary amount of time.
2) At the same time, it should not be very close to the dairy operations where there can be lot of noise, vibrations, steam etc. In other words, it should be free from noise and vibration.
3) It should preferably be away from boiler houses.
4) It should be easily accessible for all the major activities of the dairy.

19.1.3 Layout/design of the laboratory

1) Laboratory should have adequate number of rooms/chambers and benches etc of suitable dimensions.
2) While setting up a laboratory, the possible expansion of the dairy should be kept in view.
3) Every laboratory should be provided with a minimum of 2 exits.
4) For each category (A, B, C, D, E) of lab, BIS has given two alternate layout plans.

19.1.4 General requirements for a QC lab

1) Walls

Walls of the lab should be smoothly finished. For example, they may be tiled with glazed tiles particularly in the wash up room and on the platform where the Gerber test is conducted.

2) Windows

There should be sufficient number of windows fitted with glass panes to receive adequate natural light.

3) Lighting

i) There should be adequate satisfactory natural day light.
ii) Northern or east-northern exposure is preferred for a satisfactory natural day light, particularly for color matching etc.

iii) Lights should be provided to give a minimum average intensity of 400 to 450 lumen/m² at working level.

**Note**

Instruments are available for measuring the intensity of light, like the one used in cricket grounds etc.

iv) Direct sun light should be avoided particularly for sensitive instruments (e.g. Chemical balance)

v) A roof light is helpful.

4) **Flooring**

(i) Flooring should be non-slippery.

(ii) Flooring should be capable of cleaning easily.

5) **Store room**

There should be two store rooms.

(a) One for acids, alkalies and ammonia

(b) Second for fine chemicals, glasswares, apparatus and equipments.

6) **Benches**

There are several designs/sizes of benches. Some of the examples are as:

- 150 x 75 x 90 cm
- 220 x 75 x 90 cm
- 360 x 67.5 x 90 cm
- 150 x 75 x 75 cm
- 210 x 75 x 75 cm

Any convenient size can be used.

Bench top should be made of material resistant to acid and alkali (For example, acid and alkali proof tiles or sunmica may be used).

A. **Above bench fittings**

Shelves should be provided above the bench to keep various solutions, chemicals, reagent bottles, glassware etc.
B. Under Bench fittings

The drawers and cupboard with shelf accommodation should be provided. The under bench unit could be of fixed or removable type and inter changeable.

7) Cupboards

Lab should have adequate number of cupboards - not only to protect the apparatus but also to give neat and clean appearance. For this, wall cupboards are preferred which provide space for storing some of the material without occupying the floor space.

8) Sinks

A. Sinks of suitable dimensions should be provided in wash-up rooms. They may be made of glazed earthenware or vitreous ware or stainless steel. Preferable dimensions of sinks for wash-up room are 75 x 45 x 25 cm.

B. Sinks for Service bench or laboratory bench or working bench should be fitted beneath (i.e. by the side of) the bench top. They may be made of porcelain or other suitable material. Dimensions for such sinks are 45 x 30 x 20 cm.

9) Fume cupboard/fume hood/fume chamber

There should be a fume cupboard provided with an efficient means of removing objectionable fumes, gases, vapors etc for carrying out operations which cause fumes etc. Fume chambers should have the provision for gas, water, waste outlet and electricity.

Fig. 19.1 Fume hood
10) **Water supply**

There should be adequate water supply.

11) **Distilled water plant**

Distilled water plant of adequate capacity should be available in each lab (Fig 19.2).

![Fig. 19.2 (a) Metal Distillation Assembly](image1)

![Fig. 19.2 (b) Glass Distillation Assembly](image2)

![Fig. 19.2 (c) Quartz Distillation Assembly](image3)

12) **Gas**

Each lab should have provision of gas supply, in the form of own gas supply, in the form of own gas plant or portable gas supply.

13) **Electric supply**

Each lab should have electric supply. Electric points for water bath, heaters oven etc. should be provided.

14) **Service lines (of water, gas & electric power)**

The service lines, namely, those of tap water, electric power and gas, should run along the walls, concealed 80 cm above floor level and connection taken to the laboratory benches.

While installing service lines, two main points should be kept in mind:
a. Benches should be easily removable.
b. Service lines should be easily accessible.

15) **Drainage**

Underground drainage system should be there.

16) **Fire-extinguishers**

Laboratory shall be equipped with fire extinguishers of suitable sizes and first aid box.

17) **Ventilation**

To ensure sufficient or proper ventilation, an exhaust fan of suitable size should be provided.

18) **Air-Conditioners**

Each laboratory, as far as possible, shall be air – conditioned.

19) **Chemicals, glassware & Consumable Stores**

Laboratory should be equipped with necessary chemicals, glassware and consumable Stores.

20) **Equipments**

Laboratory should be equipped with necessary equipments.

**19.1.5 List of equipments ordinarily required in QC lab**

- Mojonnier apparatus, water baths

**Fig. 19.3 Mojonnier flask and flask stand**
19.1.6 Special Requirements for specific purposes

1. Fat Test

A white tiled platform of suitable dimension would be found to be useful for conducting fat test.

2. Wash-up Room

In wash up rooms, it is desirable to have 3 sink units with draining board and draining rack.

3. Balance Room

The balance room should be so located in laboratories that it is least affected by vibrations.

4. Doors

The doors of the laboratory should be self closing.

5. Bacteriological Room

The bacteriological room should be dust-free and air-conditioned.
6. Drains

The drains should be made of an acid-proof material. While constructing the drains, the volume of discharge should be taken into account. The drains should be provided with suitable traps at suitable places to prevent blockage of drains.

7. All the rooms meant for analytical work in the laboratory should be fly-proof and rodent proof.

19.1.7 Various chemical tests ordinarily conducted in a dairy laboratory

1. Organoleptic test
2. Sediment test
3. Alcohol test
4. COB test
5. Acidity
6. Fat
7. SNF
8. Freezing point determination
9. Adulterants
10. Preservatives
11. Neutralizers
12. Phosphatase test
13. Hardness of water
14. Available chlorine (Cl2)
15. pH
16. Turbidity test
17. Salt (NaCl) purity
18. BR at 40°C
19. Reichert–Meissl value (RM) and Polenske value (PV)
20. Acid value
21. Sugar/lactose
22. Over-run (weight per liter)
23. Strength of alkali/acid etc.

19.2 Mobile Testing Laboratories

The mobile laboratory is the integrated analytical platform equipped with state-of-the-art measurement systems. It is to detect, analyze and confirm the chemical and biological adulterants/contaminants in food, water, milk etc. This lab in real sense is full-fledged traditional laboratory in the field as a mobile unit. However, in some cases it can be a mobile unit with limited tests in the field of food/ dairy analysis and
depending upon the needs the laboratory can be designed. The mobile testing laboratory for the detection of food adulteration includes some rapid chemical and microbiological tests in particular. This lab should have proper safety features like pressurized air system, biological safety cabinet etc. These labs are fabricated on a specially modified mobile platform like heavy duty trucks. The concept of mobile testing laboratories is already in place in many developed countries as well as in some developing countries. In India, the newly formed Food Safety and Standards Authority (FSSAI) has taken an initiative to setup the mobile testing laboratories. These Mobile Labs are expected to be positioned at various locations in the country, including Delhi on the basis of risk assessment.

**Fig. 19.4 Mobile testing**

### 19.3 Objectives of Mobile Testing Laboratory

To take process of food testing to the door steps of the consumers and others.

i) The labs will visit the local markets, households, restaurants, godowns, schools and other public places, conduct tests on the spot and declare the result, thereby creating awareness among the people and also furnish feedback to the food safety authorities.

ii) Collection of information by means of testing and preparation of a data base, which can be useful in maintaining surveillance and could also be utilized by the Food Safety Officers, Laboratories and others involved in Food Safety regulation.

### 19.4 Design of the Laboratory

The mobile testing laboratory is generally constructed by laminated panels with excellent insulation properties. These panels are mounted in a galvanized steel frame. External dimensions generally depend upon the type and kind of testing to be carried out in a particular laboratory. The container is designed in such a manner that it can be lifted by both crane, truck with container hoist and can be transported by truck, ship, train and aeroplane. These laboratories can also be fitted in the heavy duty trucks. The laboratory can be divided into two portions internally by a sliding door. One half of the laboratory can be used for the preparation of samples and the other functions as a measurement laboratory where instrumentation can be located. The platform includes both rear and side entry doors with dual pan windows. The units should be equipped with adequate number of generators most likely two numbers one on each side of the platform. These are directly controlled from the outside or from a control panel.
located inside the laboratory compartment. Additionally there should be filtered fresh air intakes and exhaust vents with HEPA (High Efficiency Particulate Air) filters to avoid contamination of environment. A basic mobile laboratory should have the following features:

Fig. 19.5 Laboratory

19.4.1 Mobile laboratory

At least 20 ft. container made up of laminated aluminium panels with excellent insulation mounted in a galvanised steel frame. Ext. dimensions: 606 x 244 x 244 cm.

i) Provision for a connection to external power supply (230 - 400 V).
ii) Facilities for connection to external water supplies, air conditioning and internal climate control for operation in adverse weather conditions.
iii) Separate air conditioning and ventilation systems.
iv) Built in diesel generator for power supply in the event of power cuts.
v) Fume hood, refrigerator/freezer/microwave.
vi) Lines for telephony, data, internet, e-mail.

19.4.2 Equipment

Type of equipment depends upon the kind of testing to be performed. The possible equipments are as:
i) Sampling equipment and containers.
ii) Milko tester/Milk analyzer
iii) Ovens, Incubators.
iv) Gerber Centrifuge and clinical centrifuge.
v) Rapid chemical testing kit.
vi) Rapid microbiological testing kits
vii) Biosensor based tests for antibiotics etc.
viii) Lactometers,
ix) Computers (PC’s), Printer
x) Protective equipment, electronic personnel.