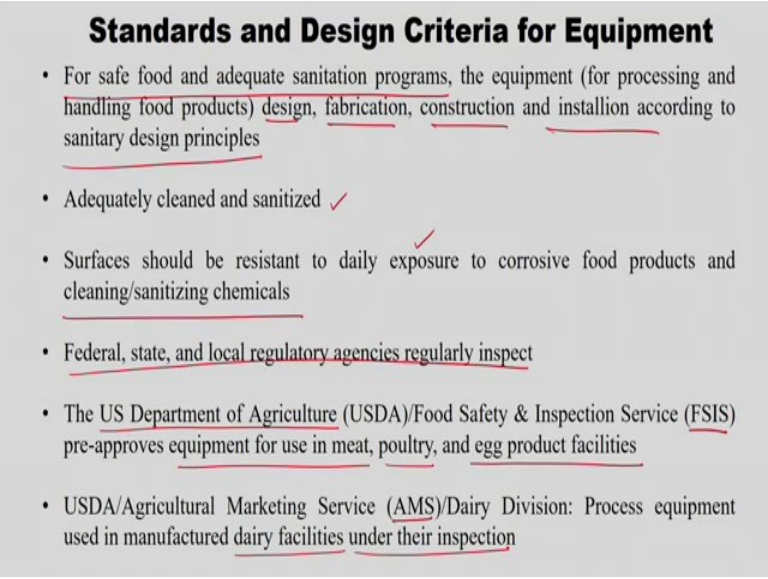
Thermal Processing of Foods
Professor R. Anandalakshmi
Chemical Engineering Department
Indian Institute of Technology Guwahati
Lecture No. 29
Sanitary Components and Requirements

Good morning everyone, so today we are going to discuss about sanitary components and its requirements. So, till we are almost end of the course and till now what we have discussed is thermal processing, various thermal processing, also we have discussed about specialized equipments, dryers and heat exchangers.

And also we discussed about special processing techniques for the food which are nothing but membrane separation processes and extrusion processes and last few classes we have also seen about the food biosensors and nutraceuticals food components etcetera. So, this particular week we are going to discuss about the sanitary components and its requirements and also the regulatory considerations.

(Refer Slide Time: 01:31)



So, the introduction goes like this, the standards and design criteria for equipment. So, for safe food and adequate sanitation programmes, the equipment whatever we use it for processing and handling food products, so they should be designed, fabricated, constructed and installed according to the sanitary design principle. So, especially in food industry this is very much

important, so in almost every lecture I also insist upon the good manufacturing practices. So, beyond that what else standards are available, that is what we are going to see.

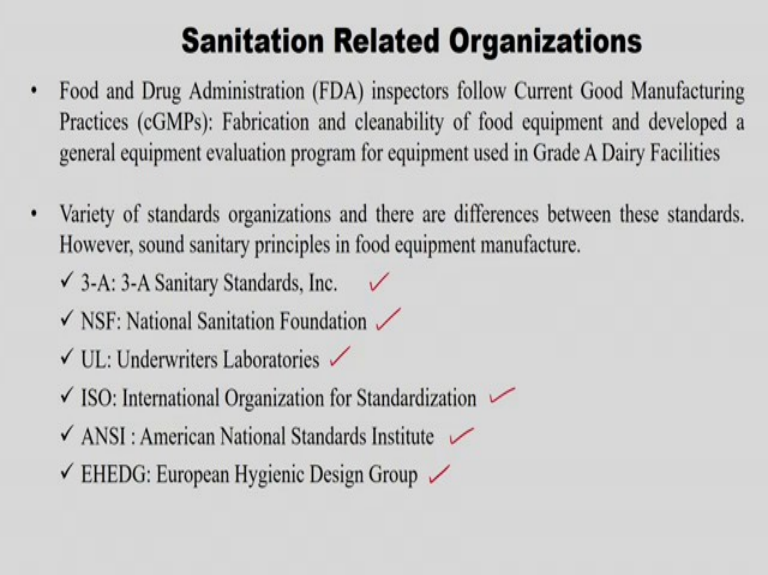
And these food processing equipments or food handling equipments also should be adequately cleaned and sanitized. The food contacting surfaces, so they should be of resistant to daily exposure of corrosive food products and cleaning and sanitizing chemical. So, they should be resistant over corrosive food products and also the cleaning and sanitizing chemicals.

And so who inspect this? So, the federal, state and local regulatory agencies regularly inspect these food processing and food handling equipments. And there is a US department of agriculture, it is called as USDA and Food Safety and Inspection Services, so that is FSIS, so they pre-approves the equipment for use in meat, poultry and egg product facilities.

And the same USDA along with Agricultural Marketing Service which is nothing but AMS and their Dairy Division, so they inspect the process equipment used in the manufacturing of dairy facilities under their inspection. So, here it is very much important for the food processing equipments and food handling surfaces should be designed, fabricated, constructed and installed according to the sanitary design principles and also they should be adequately cleaned and sanitized and these surfaces should be of resistant to daily exposure to corrosive food products and as well as the cleaning and sanitizing chemicals.

And the inspection is regularly done by the federal, state and local regulatory agencies and the US department of agriculture and food safety inspection service, personnel are involved in pre-approving the equipment which are used in meat, poultry and egg product facilities. And the same USDA along with the Agricultural Marketing Services, so there is a dairy division under Agricultural Marketing Service, that dairy division along with USDA inspect the process equipment used in the manufacturing of dairy facilities.

(Refer Slide Time: 04:43)



So, what are all sanitation related organizations, so that is what we are going to see here. And Food and Drug Administration, so this is every one of us know, so most of the food products, food related issues and the consumption of food and any toxic levels, most of the time we refer the FDA approval or we check for the FDA approval, so which is nothing but Food and Drug Administration.

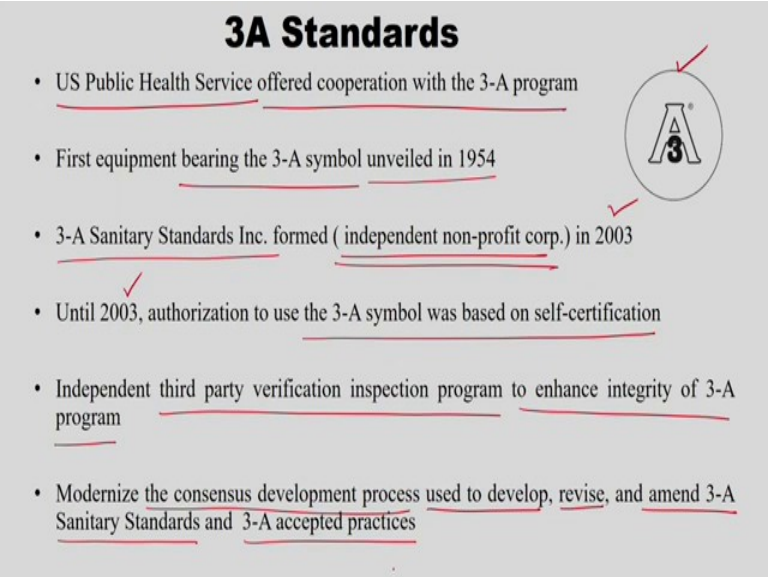
So, inspectors who are belong to Food and Drug Administration, they follow the current good manufacturing practices, which is called cGMPs. So, which talks about the fabrication and cleanability of food equipment, developed a general equipment evaluation program for equipment used in Grade A Dairy Facilities.

So, the FDA inspectors, follow this current good manufacturing practices which is nothing but cGMP, so this is responsible for fabrication and cleanability of food equipment and also they developed a general equipment evaluation program for equipment used in Grade A Dairy Facilities. So, this we have discussed in our pasteurization lecture itself that Grade A milk quality, so what are all the qualities and the equipment to be used and what are all the design specifications used for those equipments which are used in Grade A Dairy Industry.

And variety of standard organizations are there and there are difference between these standards. So, almost here itself we have, we are seeing almost 6 standardizations, so though we have different standard organization and difference between their standards but the ultimate goal of

this sanitation related organization is to take extreme care and sound sanitary principles should be applied on the food equipment manufacturing. Like so in that line, there are 6 sanitation related organizations today we are going to see, so the one is 3-A Sanitary Standards, Inc. and a National Sanitation Foundation and Underwriters Laboratories and International Organization for Standardization and American National Standards Institute and European Hygienic Design Group. So, each one them we will see in detail.

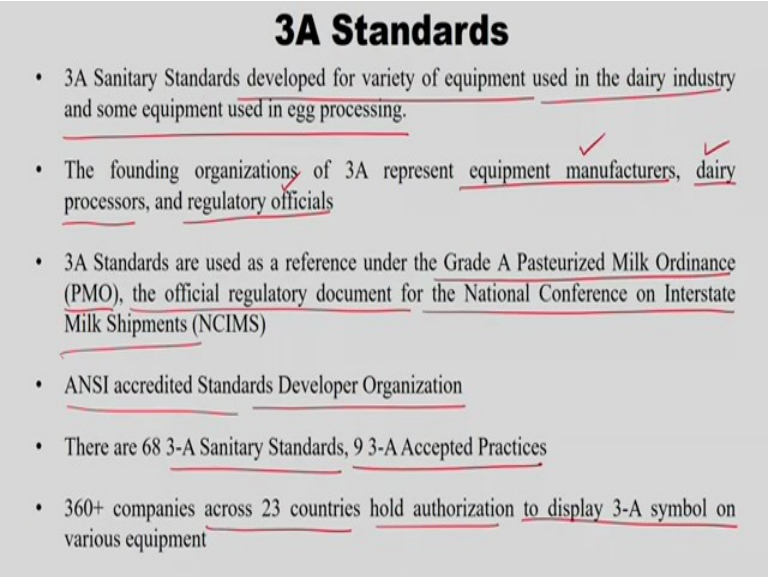
(Refer Slide Time: 07:15)



So, the first one is 3A standards, the design symbol is this and this is in line with the US Public Health Service, so the US Public Health Service offered cooperation with the 3A program. And the first equipment bearing 3A symbol unveiled in 1954. And this 3A Sanitary Standards Inc. formed in 2003, so this is formed as an independent non-profit corporation. So, until 2003, the authorization to use 3A symbol was based on the self-certification.

So, now it is a third party verification inspection program also included in 3A standards to enhance the integrity of 3A program. And there are developments, still in the 3A standards to modernize the consensus development process used to develop, revise and amend 3A Sanitary Standards and 3A accepted practices. So, this goes regular developments and revise and certain amendments in their standards and accepted practices.

(Refer Slide Time: 08:31)



So, the 3A Sanitary Standards developed for variety of equipment used in the dairy industry and some equipment used in egg processing industry. The founding organization of 3A represent equipment manufacturers, dairy processes and regulatory officials. So, probably that is why the 3A, the founding organizations of 3A represents all 3 groups, equipment manufacturers and dairy processes as well as the regulatory officials.

So, the 3A Standards are used as a reference under a Grade A Pasteurized Milk Ordinance, so PMO this is what we might have discussed milk pasteurization lecture itself. So, the 3A Standards are used as a reference under the Grade A Pasteurized Milk Ordinance, Grade A PMO, the official regulatory document for the National Conference on Interstate Milk Shipments, NCIMS.

So, in NCIMS this is used as a official regulatory document for dairy standards or especially milk. Then ANSI accredited the Standards Developer Organization and there are 68 3A Sanitary Standards and there are 9 3A accepted practices. There are 360 plus companies across 23 countries hold this authorization to display 3A symbol on various equipment.

(Refer Slide Time: 10:07)

So, the next one is the National Sanitation Foundation which is NSF, so this is the symbol. And this is also a non-profit organization founded in 1944, whose headquarter is in Ann Arbor, Michigan. And the goals is to develop standards, certify products and manage risk and focus on food, water, air quality, environment. Air quality as well as environmental issues.

The National Sanitation Foundation developed standards for equipment used in food service and retail foods. So this NSF, the National Sanitation Foundation, it is not exclusively for food products, so they have developed standards and certify products and manage risk, not only in the food, so along with food, water, air quality and environment is also there but what we wanted is the standards for equipment used in the food service and retail foods.

The NSF develops standards for food processing equipment and in collaboration with 3A. 3A standards what we have seen, the NSF collaborated with 3A and came with the standards development for meats and poultry equipment, so which is nothing but 3A/NSF 15159, which is reviewed by an International Organization for Standardization working group.

So, though we are discussing about each and every sanitation related organization individually, so we also here seen one of the organization NSF, they already collaborated with 3A to come for the equipment practices for meats and poultry equipment and also this is reviewed by another sanitation regulatory organization which is nothing but International Organization for Standardization.

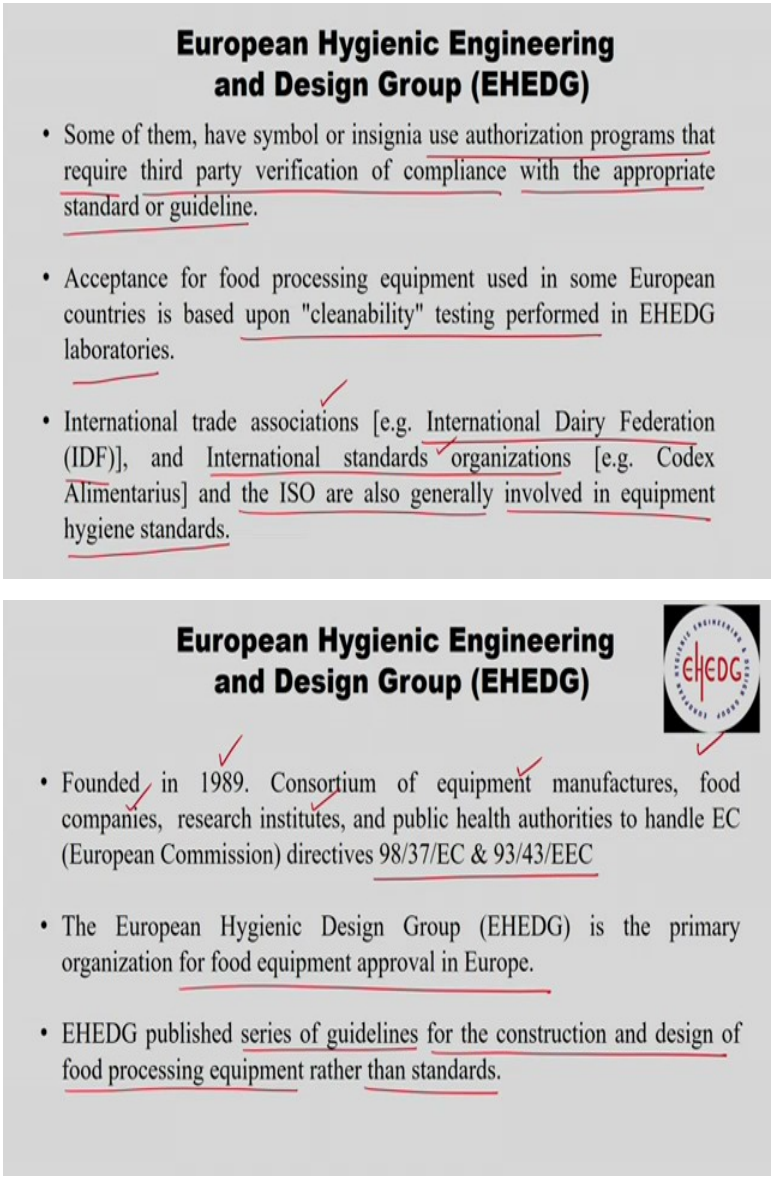
(Refer Slide Time: 12:12)

The next one is European Hygienic Engineering and Design Group, so this is founded in 1989 which is a consortium of equipment manufacturers, food companies, research institutes and public health authorities to handle European Commission directives, to handle EC directives, so which is nothing but 98 upon 37 EC and 93 upon 43 EEC.

So, these are nothing but the directives which come from EHEDG. The European Hygienic Design Group is the primary organization for food equipment approval in Europe, so in Europe the food equipment or food processing or food handling equipment approval should be done by a this EHEDG group.

And this EHEDG organization published series of guidelines for the construction and design of food processing equipment rather than standards. So, they have not developed any standards but they have developed series of guidelines and published for the construction and design of food processing equipment. So, this is the symbol of EHEDG.

(Refer Slide Time: 13:25)



And some of them have symbol or insignia use authorization programs that require third party verification of compliance with the appropriate standard or guideline. So, some of these guidelines proposed by or published by EHEDG organization, needs the third party verification with the appropriate standard or guideline.

The acceptance for food processing equipment used in some European countries is based upon the cleanability testing performed in EHEDG laboratories, the cleanability test will be performed in their EHEDG laboratory itself and we have also seen here, so this is the group of equipment

manufacturers, food companies, research institutes as well as the public health authorities, so they also have their own labs to check the testing based on cleanability.

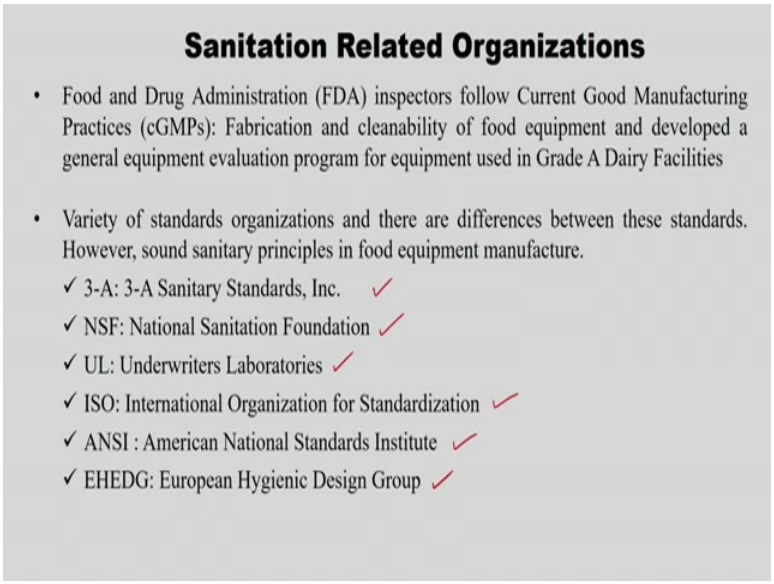
And International trade associations, so example is International Dairy Federation, IDF and International Standards Organization, so example is Codex Alimentarius and the ISO are also generally involved in equipment hygiene standards. So, not only EHEDG group, so the International trade associations, International Standards Organizations, so these also involved in equipment hygiene standards.

(Refer Slide Time: 15:00)

No.	Title
2	A method for assessing the in-place cleanability of food processing equipment
5	A method for the assessment of in-line sterlisability of food processing equipment
8	Hygienic design principles
26	Hygienic engineering of plants for the processing of dry particulate materials
32	Materials of construction for equipment in contact with Food.
34	Integration of hygienic and aspectic systems
35	Hygienic welding of stainless steel tubing in the food processing industry
37	Hygienic design and application of sensors

European Hygienic Engineering and Design Group (EHEDG)

- Some of them, have symbol or insignia use authorization programs that require third party verification of compliance with the appropriate standard or guideline.
- Acceptance for food processing equipment used in some European countries is based upon "cleanability" testing performed in EHEDG laboratories.
- International trade associations [e.g. International Dairy Federation (IDF)], and International standards organizations [e.g. Codex Alimentarius] and the ISO are also generally involved in equipment hygiene standards.

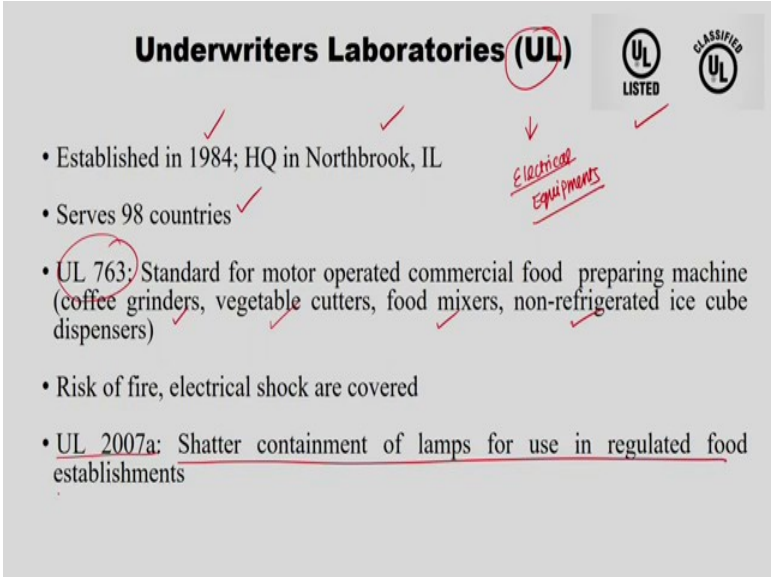


So, the example of this EHEDG guideline, so whatever I have taken it from this particular website of EHEDG. So, there are certain guidelines I am highlighting here, so you may would like to check the other guidelines available in their websites itself. All these 6 sanitary related organizations got their own website, so you may would like to check each of them and their guidelines and standards in their website itself. So, I have taken a very picked ones, so the number 2 talks about the method for assessing the in-place cleanability of food processing equipment.

Number 5 a method for the assessment of in-line sterlizability of food processing equipment. Hygienic design principle is given by number 8 and hygienic engineering of plants for the processing of dry particulate materials, so that is given by 26. And materials of construction for equipment in contact with food is given by number 32 and integration of hygienic and aseptic systems is given by number 34. And hygienic welding of stainless steel tubing in the food processing industry is given by number 35 and hygienic design and application of sensor is given by number 37.

So, the EHEDG guidelines, the number is here and their title is there, so inside which it discusses about in detail. So, that is anyway we are going to generally discuss about the food processing equipment and their what are all the measures we need to take care in general but each one of this sanitation related organization got their own standards and practices, so that you can refer on their website itself.

(Refer Slide Time: 17:01)



The next one is Underwriters Laboratories, the symbol is this UL and this is established in 1984 here with the headquarter in Northbrook, Illinois. It serves for 98 countries and especially UL's 763 standard for motor operator commercial food preparing machines which includes coffee grinders, vegetable cutters, food mixers, non-refrigerated ice cube dispensers, etcetera. So, actually this UL Laboratory or Underwriters Laboratory, mostly developed the standards for electrical related equipments.

So, this we also use in food processing industry, so that is why I have mentioned here UL 763, so these are nothing but standards for motor operator commercial food preparing machines and they also cover risk of fire and electrical shock in the food industry. And UL 2007a which talks about shatter containment of lamps for use in regulated food establishments. So, mostly this particular sanitation related organization, works for the standards and practices in electrical related equipments.

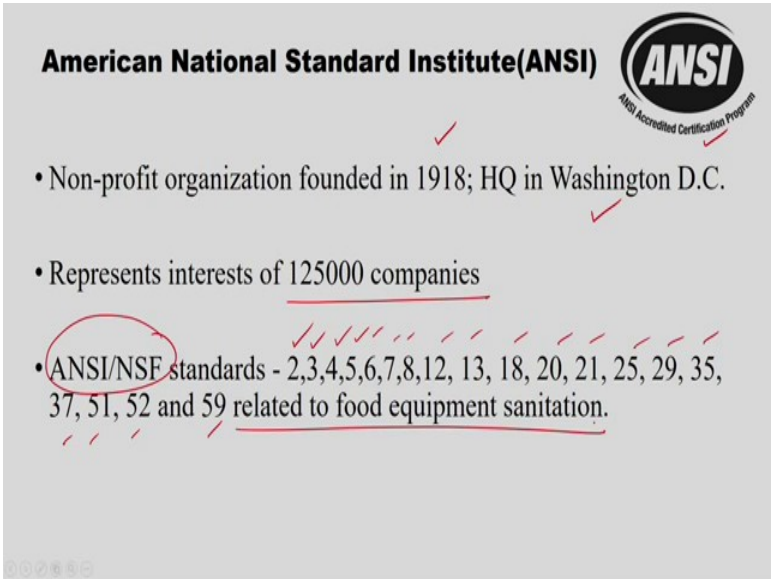
(Refer Slide Time: 18:26)

The next one and important one is the International Organization for Standards, ISO Standards, so most of the time we also heard about the world's largest developer and publisher of international standards. So, they founded in 1947, network of national standards institutes of 164 countries and 1 member per country is involved in that, with headquarter in Geneva, Switzerland.

So, the representatives are from the government as well as from industry. The ISO Standards make development, manufacturing and supply of products and services more efficient, safe and clean processing and the ISO Standards also facilitate the trade between the countries and make it fairer and easier. And it also provides the government with a technical base for health, safety, environmental legislation and conformity assessment.

And they also share technological advances and good management practices and they disseminate innovation and they safeguard the consumers and users of products and services and make life simpler by providing solutions to common day to day problems. So, the ISO Standards are very much popular one.

(Refer Slide Time: 19:46)



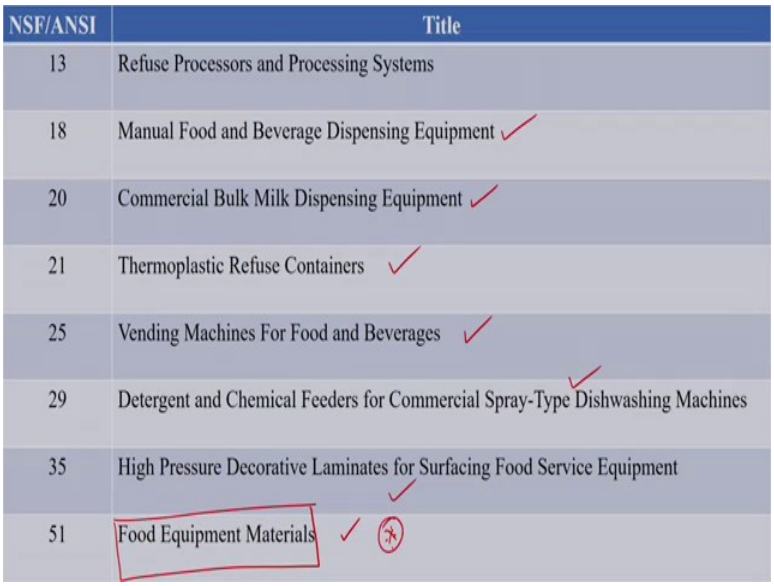
The next one is ANSI, so American National Standard Institute, the symbol is this. So, again this is also non-profit organization, founded in 1918 with the headquarters in Washington D.C. So, they represents the interest of almost 1,00,000 plus companies and ANSI/ NSF, so as I said earlier so they both collaborated together, came up with a standard practices. So, they are numbered in various level but the 2,3,4,5,6,7,8,12,13,18,20,21,25,29,35,37,51,52 and 59, they are related to food equipment sanitation.

(Refer Slide Time: 20:34)

NSF/ANSI	Title
2	Food Equipment
3	Commercial Warewashing Equipment
4	Commercial Cooking, Rethermalization and Powered Hot Food Holding and Transport Equipment
5	Water Heaters, Hot Water Supply Boilers, and Heat Recovery Equipment
6	Dispensing Freezers
7	Commercial Refrigerators and Storage Freezers
8	Commercial Powered Food Preparation Equipment
12	Automatic Ice Making Equipment

So, we are going to see quickly the NSF/ANSI, standard 2 talks about the food equipment, 3 talks about commercial warewashing equipment, the 4 talks about commercial cooking, rethermalization and powered hot food holding and transport equipment and the 5th number deals with water heaters, hot water supply boilers and heat recovery equipment. And the 6th number discusses about dispensing freezers and 7th number discusses about commercial refrigerator and storage freezers. And 8th one represents about commercial powered food preparation equipment and the 12th one talks about the automatic ice making equipment.

(Refer Slide Time: 21:14)

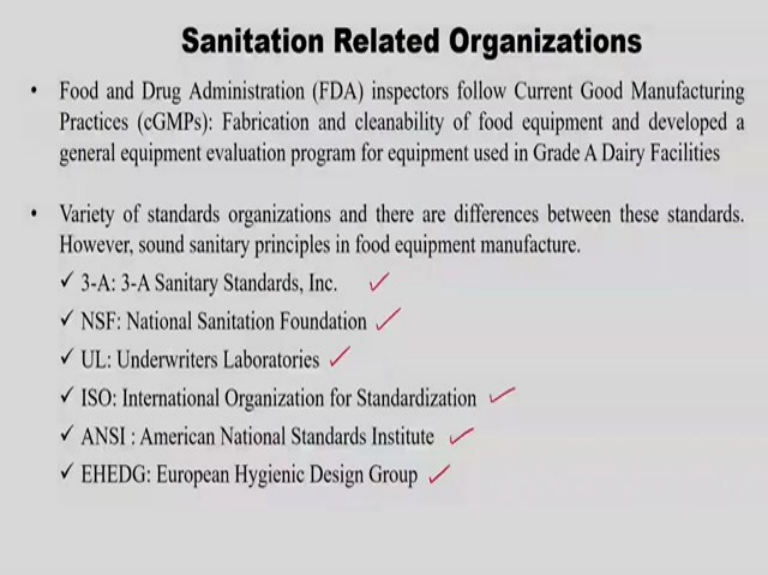


NSF/ANSI	Title
13	Refuse Processors and Processing Systems
18	Manual Food and Beverage Dispensing Equipment
20	Commercial Bulk Milk Dispensing Equipment
21	Thermoplastic Refuse Containers
25	Vending Machines For Food and Beverages
29	Detergent and Chemical Feeders for Commercial Spray-Type Dishwashing Machines
35	High Pressure Decorative Laminates for Surfacing Food Service Equipment
51	Food Equipment Materials

And the number 13 represents refuse processes and processing system and 18 number talks about the manual food, beverage dispensing equipment and 20th one discusses about commercial bulk milk dispensing equipment. 21 thermoplastic refuse containers, 25 vending machines for food and beverages, so whatever we use in our cafeterias and 29 discusses about the detergent and chemical feeders for commercial spray type dishwashing machines.

And 35 discusses about high pressure decorative laminates for surfacing food service equipment and 51 talks about this one is specifically food equipment and materials. So, this is as an example I just put it, so you can also browse in their website to get to in detail because here in 1 hour class to discuss about the main points given in each particular title would be bit difficult. So, I request you to check in their website, so if you want to know anything in depth further.

(Refer Slide Time: 22:31)



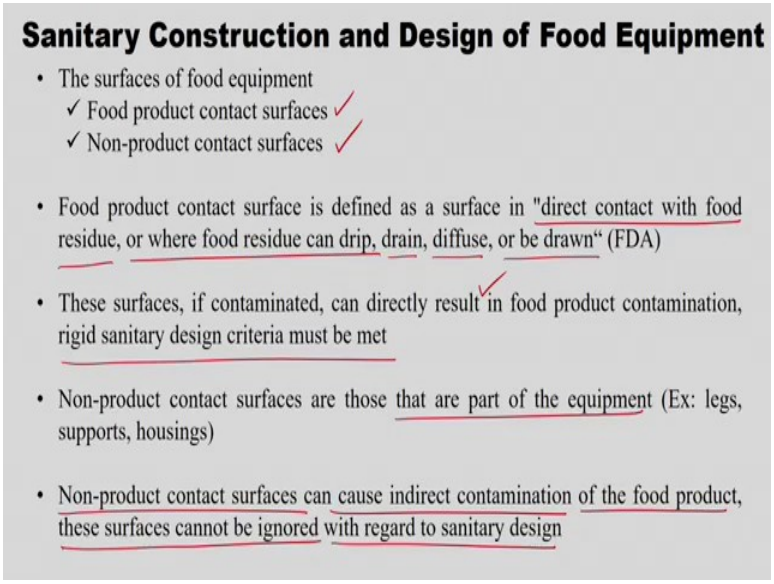
So, whatever we have discussed about 6 organizations, sanitation related organization, so they are nothing but 3A Sanitary Standards, National Sanitation Foundation, Underwriters Laboratories, International Organization for Standardization, American National Standards Institute and European Hygienic Design Group.

So, though we have seen bit different in their standard practices and the guidelines, so the ultimate aim of each organization is to ensure the food safety. And safe food processing and food handling equipments. So, as we have seen every organization got their own standards and practices, so discussing them one by one would be very vast because the course is all about the processing.

(Refer Slide Time: 23:25)

So, here we are going to see the general aspects of sanitary design, so which was mostly derived from all these standards and practices developed by sanitation related organizations. So, instead of discussing each one of them under the title, so we are going to put it in a generalized format, so that we get to know the basic standards and good manufacturing practices.

(Refer Slide Time: 23:51)



The first one is the sanitary construction and design of food equipment, so what are all the general aspects we need to take care. The surface of food equipment can be categorized into 2, one is food product contact surface, another one is non-product contact surface. The food product

contact surface is defined as a surface in direct contact with the food residue or where the food residue can drip, drain and diffuse or be drawn. So, the surface in which the direct contact with food residue can drip, drain, diffuse or be drawn, is defined as a food product contact surface by FDA, the Food and Drug Administration.

So, these surfaces if contaminated, can directly result in food product contamination, and rigid sanitary design criteria must be met before going for food processing. And non-product contact surfaces are those that are part of the equipment, example is legs, supports, and housings and these non-product contact surfaces can cause indirect contamination of the food product and these surfaces cannot be ignored with regard to sanitary designs.

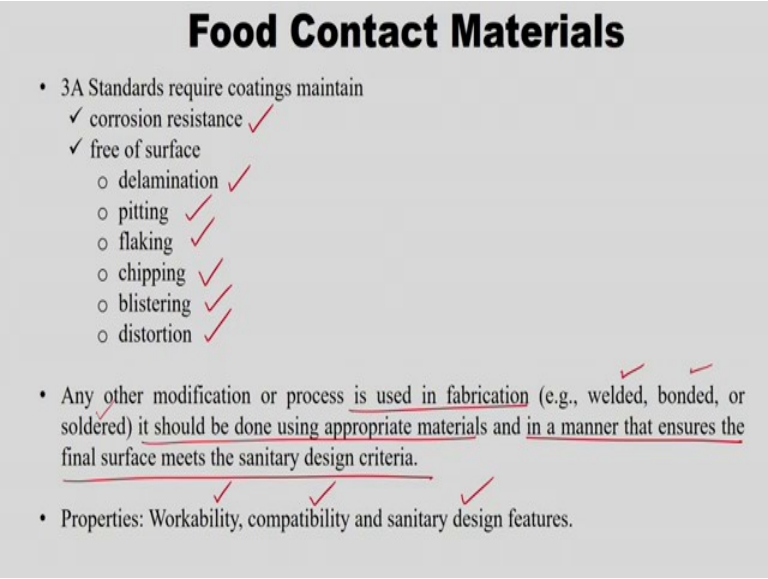
So, we cannot neglect these non-product contact surfaces, so one example I have told you, in one of the dryer, so one particular dryer has a door, so when we keep the material inside so there maybe the environment around it also may lead to contamination. So, that is where this particular point is discussed here. The non-product contact surfaces can cause indirect contamination of the food product and these surfaces cannot be ignored with regard to sanitary design.

(Refer Slide Time: 25:41)

So, the food contact surfaces maybe coated with metal alloy or non-metal, so example is ceramics, plastics and rubber. So, they should be very smooth and impervious and free of cracks and crevices and non-porous, non-absorbent and non-contaminating, non-reactive, corrosion resistant, durable and maintenance free, nontoxic and easily cleanable. So, these are all the

characteristics one would look for any food contact surfaces coated with metal alloy or non-metal.

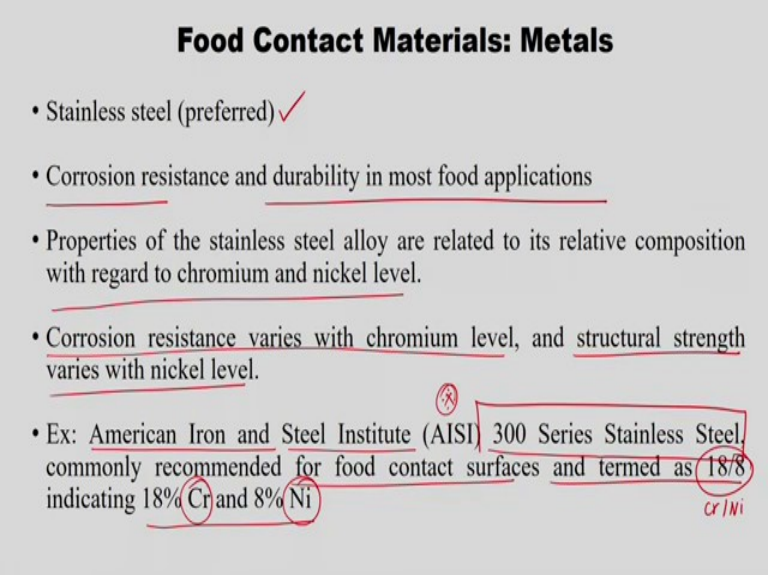
(Refer Slide Time: 26:21)



So, these food contact material coatings require 3A standards, so that maintains the corrosion resistance and free of surface delamination and free of surface pitting and free of surface flaking, free of surface chipping, free of surface blistering and free of surface distortion. So, there are 3A standards so which talks about all these characteristics for coatings which is applied on the food contact surfaces. And any other modification or process is used in fabrication, so that means welding sometimes, bonding or soldering, it should be done using appropriate materials and in a matter that ensures the final surface meets the sanitary design criteria.

So, intermediately if we apply any modification or any process modification or any surface modification, so in between if we apply any process modification or the food contacting surface modification, so examples are welding, soldering. So, we suppose to take care there as well the sanitary design criteria. So, that means we suppose to use appropriate materials for such modification in a manner to ensure the final surfaces meets the sanitary design criteria. So, the property of this food contact materials, should comply the standards of workability, compatibility and sanitary design features. So, what are all these food contact materials, that we are going to see now.

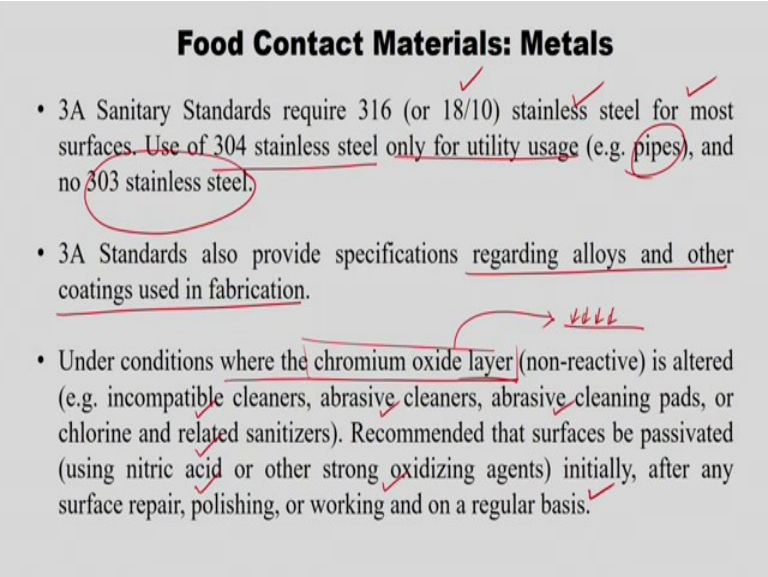
(Refer Slide Time: 28:02)



So, the first and foremost is the metals. So, in the metals always the stainless steel one are preferred, so because of their corrosion resistance and durability in most of the food applications. And the properties of stainless steel alloy are related to its relative composition with regard to chromium and nickel level. So, based on their chromium and nickel level in the alloy, so the properties would vary. So, the corrosion resistance vary with the chromium level. The amount of the chromium in the stainless steel alloy determines the corrosion resistance power and the structural strength varies with the nickel level.

So, based on the nickel percentage their structural strength is enhanced or decreased. So, example would be American Iron and Steel Institute, AISI, so they introduced 300 Series stainless steel, so commonly recommended for food contact surfaces and it termed as 18 by 18 indicating 18 percentage chromium and 8 percentage nickel. So, this contributes to corrosion resistance, this contributes to their structural strength. So, this as AISI standards so that is used for stainless steel as a food contact surfaces. So, if we say 18 by 8, so it requires chromium upon nickel. So, 18 percentage chromium and 8 percentage nickel.

(Refer Slide Time: 29:31)



So, 3A sanitary standards require 316, so stainless steel SS316 we require, so this is nothing but 18 percentage chromium and 10 percentage nickel. Stainless steel for most of the food contacting surfaces and 3 naught 4 stainless steel only for utility usages, utility means in pipes. And there should not be any usage of 3 naught 3 stainless steel, so 3 naught 3 stainless steel is banned for food contacting surfaces. So, most widely used are SS316 which has got 18 percentage chromium and 10 percentage nickel and 3 naught 4 stainless steel are used for utility usages, so example is in pipe.

And 3A standards also provides specifications regarding alloys and other coatings and used in fabrication. So, these 3A standards not only provide the food contacting surface material, so they also provide the specifications regarding alloys and other coatings used for various food contacting surface materials fabrication. And under conditions where chromium oxide layer which is a non-reactive, is altered so that means, so here what we are doing in the surface of the steel is, we are coating it with the alloy, so in that there is a chromium, so which forms the chromium oxide layer.

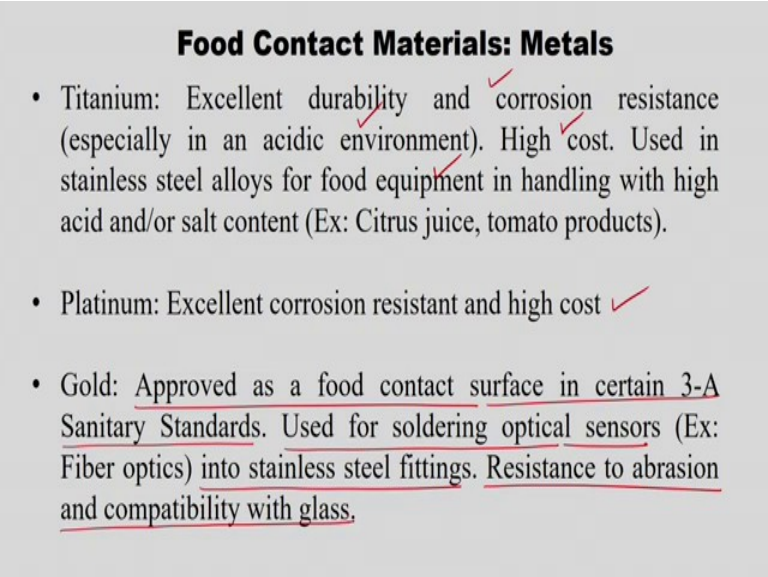
So, in the steel if the chromium is there when the oxygen is contacting into it, so this chromium oxide layer is formed and it acts as a insulator, means non-reactive surface. So, if it is altered in any of those activities, what are all they, the incompatible cleaners, abrasive cleaners or abrasive cleaning pads or chlorine and related sanitizers, then these surfaces be passivated, means using

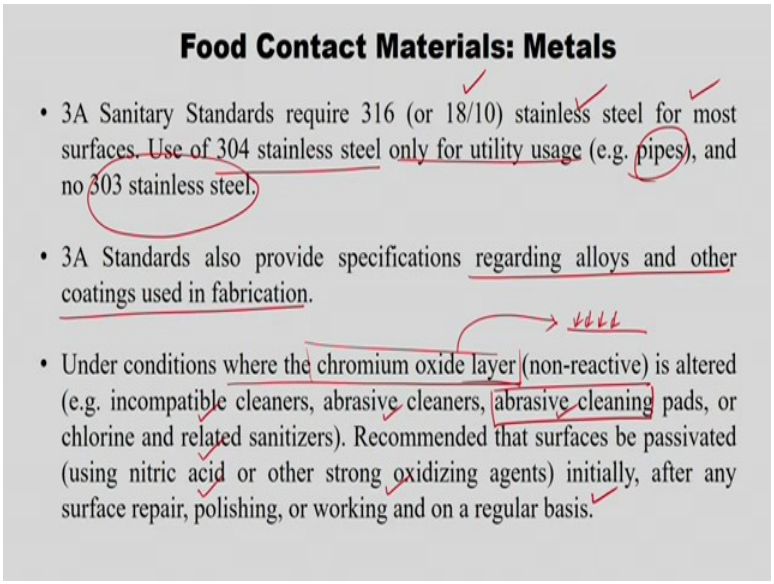
nitric acid or other oxidizing agents initially, after any surface repair, polishing or working and on a regular basis.

So, here we also need to be careful, it is not only the usage of correct food contacting surface materials, even after the use, when prolonged use is there, there may be a chance for the corrosion to happen. So, one such example is this example, so even though this chromium oxide layer is formed in the 316 or 3 naught 4 stainless steel food contacting surfaces, so these activities of incompatible cleaners or abrasive cleaners or abrasive cleaning pads, so they further cause the alterations in the chromium oxide layer. So, that further lead to contamination.

So, the recommended practice is that, the surfaces to be passivated using nitric acid or other strong oxidizing agents initially, after that any surface repair, polishing or working we need to do on a regular basis to take care, prolonged usage of the same food contacting metal materials.

(Refer Slide Time: 32:47)



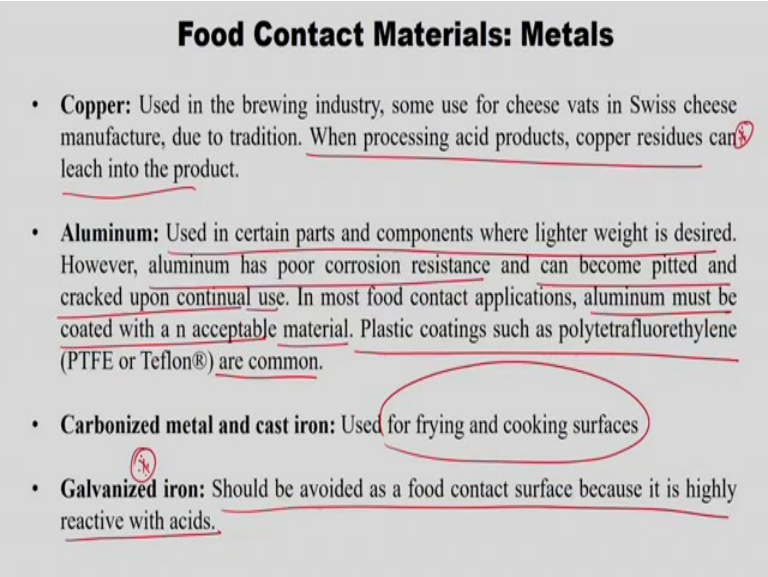


The next one is titanium, so they are used for their excellent durability and corrosion resistance, so especially in an acidic environment. But the disadvantage is their high cost and they are used in stainless steel alloys for food equipment in handling with high acid or salt content. So, the high acid food or salt content food is, food are citrus juice, tomato products, etcetera.

And the next one is platinum, so they also got excellent corrosion resistant property but the disadvantage is their high cost. And the next on is gold, so they are approved as a food contact surface in certain 3A sanitary standards. So, they are also used for soldering optical sensor, so example is optical fibre, into stainless steel fittings and resistance to abrasion and compatibility with glass.

So, they are resistant to abrasion, so here we have seen, abrasive cleaning. So, if we use the stainless steel, so abrasive cleaning further removes the non-reactive layer of chromium oxide and leads to corrosion but if we use gold surfaces, so there may not be any abrasion and they also compatible with the glass materials.

(Refer Slide Time: 34:12)



And the next one is copper which is used in the brewing industry, some use for cheese vats in Swiss cheese manufacturing due to traditional use. And when processing acid products, copper residues can leach into product. So, this is the disadvantage but copper is being used even in our kitchen utensils, from long time onwards.

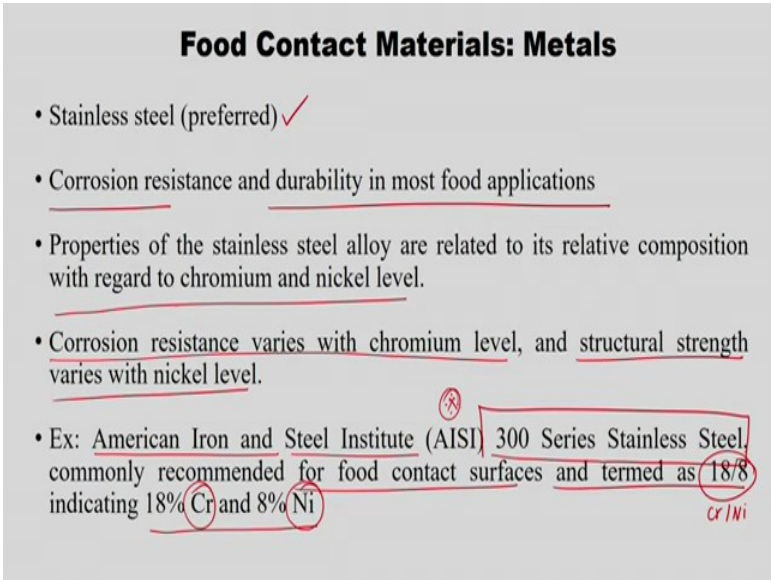
So, that is what here it is said, it is mostly used in brewing industry and still in Swiss cheese manufacturing, so to traditionally manufacture the Swiss cheese, so still these copper food contacting surfaces are being used. And when processing with the acid products, we should be extra careful because the copper residues can leach into product.

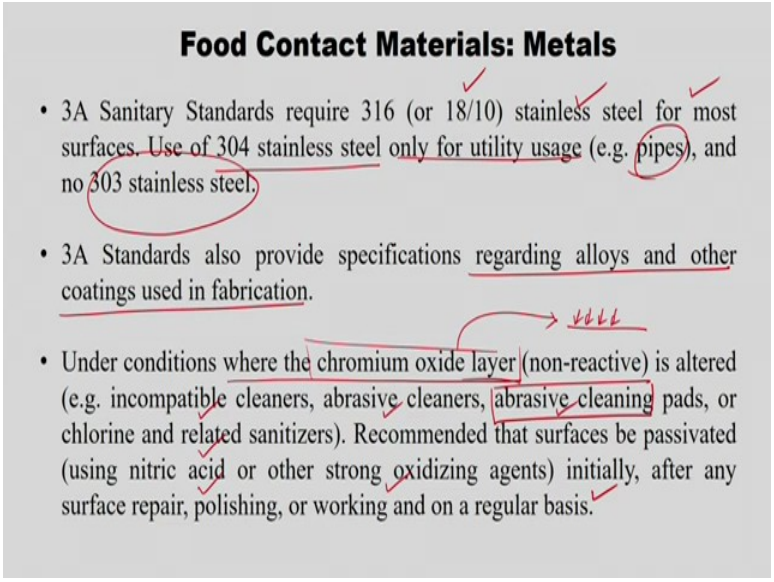
The next one is aluminium, which is used in certain parts and components where lighter weight is desired, so this we have discussed in the canning operations itself. So, aluminium has poor corrosion resistance and can become pitted, pitting corrosions and cracked upon continual use. And in most food contacting applications, aluminium must be coated with the acceptable material. So, otherwise we cannot use it because they are very much prone to corrosion.

The plastic coatings such as polytetrafluoroethylene, so which is nothing but a Teflon coating are common with the aluminium material. Then carbonized metal and cast iron, they are used for only frying and cooking surfaces, not for any manufacturing equipment practices. And the galvanized iron should be avoided as a food contacting surface because it is highly reactive with

acids. So, these particular galvanized iron materials will not be used at all in the or not used at all in the food contact materials.

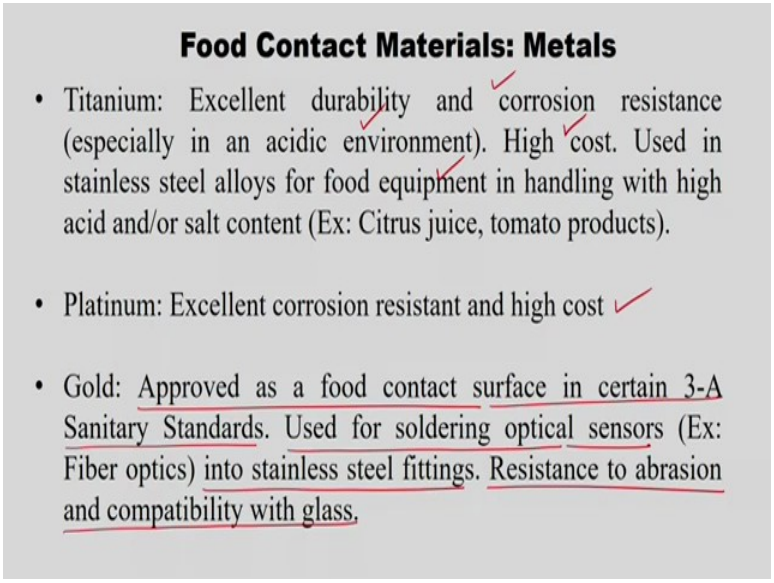
(Refer Slide Time: 36:12)





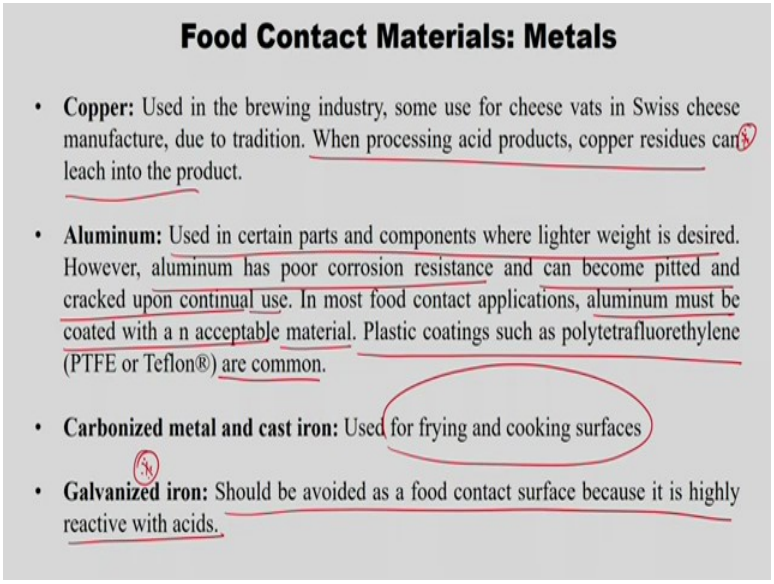
So, as a food contact materials, first one what we have seen is the metals, the most preferred one is stainless steel. Among stainless steel so the 300 series varieties, 316 so that is most widely used and 3 naught 4 is used in utility usages. And also care should be taken when we use abrasive cleaning or the chlorine and related sanitizers in stainless steel food processing equipments because that may lead to disruption of the non-reactive chromium oxide layer and lead to further corrosion.

(Refer Slide Time: 36:51)



And next one is titanium, titanium is used for its excellent durability and corrosion resistance and also they are added in the stainless steel alloy and disadvantage is they are high cost. Platinum also got excellent corrosion resistance but high cost. The gold is also same standard, so they are especially used in soldering optical sensors and so they have got good resistance to abrasion and also they are compatible with the glass material.

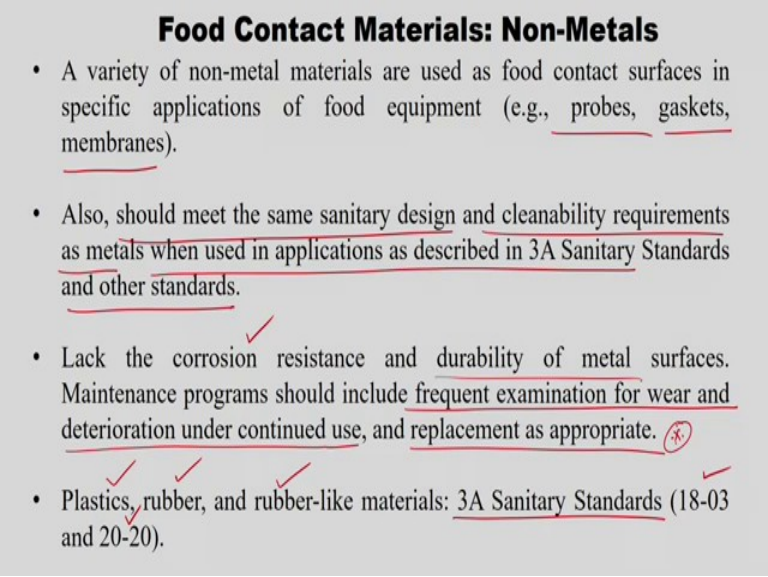
(Refer Slide Time: 37:24)



And copper from ancient time we are using but we should not use with the acid products, there may be chances for copper residues to leach into product. Aluminium, so we have already seen

in the canning operations itself but its disadvantage is its poor corrosion resistance. So, it should be coated with Teflon coating to use as a food contacting surface in the food manufacturing equipment. And carbonized metal and cast iron, especially or uniquely used for frying and cooking surfaces only. Galvanized iron, strict no as a food contact surface.

(Refer Slide Time: 38:03)



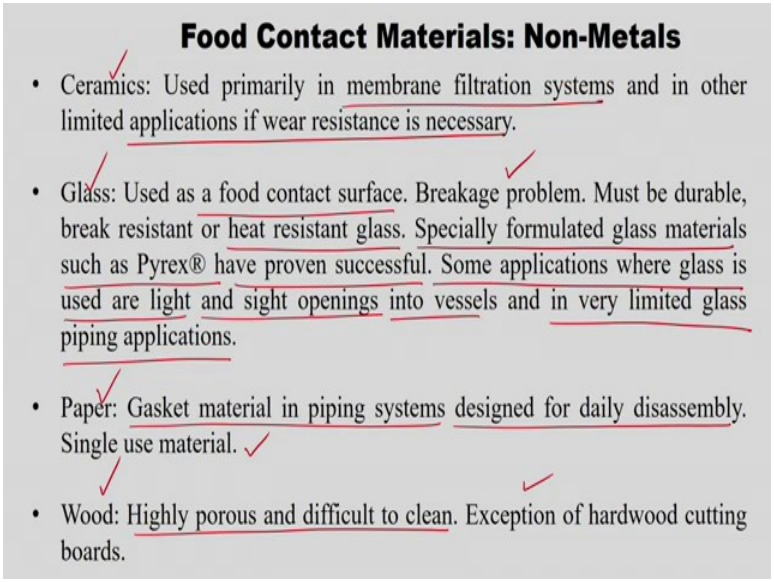
So, the next one is non-metals. So, non-metal category what are all there, so the probes, gaskets and membranes, so they are a variety of non-metal materials are used as food contact surface in specific applications of food equipment. It is not in the main equipment, but as a probes, gaskets and membranes, but still they are in contact with the food material. They should meet the same sanitary standard, so because it is a probe there are no separate sanitary design because it is also in contact with the food and cleanability requirements as metals.

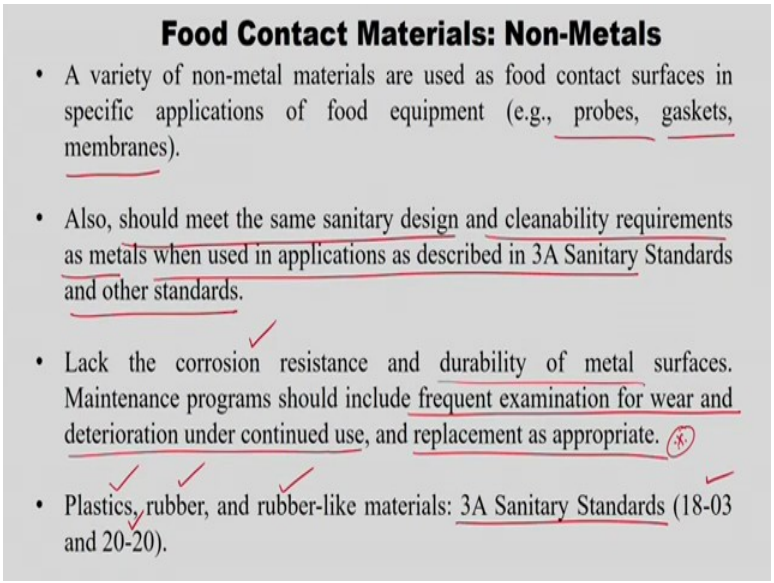
So, these non-metal surfaces, also needs the same sanitary design and cleanability requirements as metals required when used in applications as described by 3A sanitary standards and other standards. And lack of corrosion resistance and durability of metal surfaces. So, these are non-metals, they lack in corrosion resistance as well as their durability and maintenance programs should include frequent examination for wear and deterioration under continued use and replacement as appropriate.

This is what we have seen in the stainless steel itself, even in the metal contacting surfaces, so this is very much required. At regular interval we should be examining the surfaces for any

further wear and deterioration. And plastics, rubber and rubber like materials, so they are used as a non-metal food contacting surface materials. So, the 3A standards 18-03 and 20-20, discusses about the non-metals as a food contacting surfaces. So, what are all the standards to be used for non-metals as the food contacting surfaces.

(Refer Slide Time: 40:00)





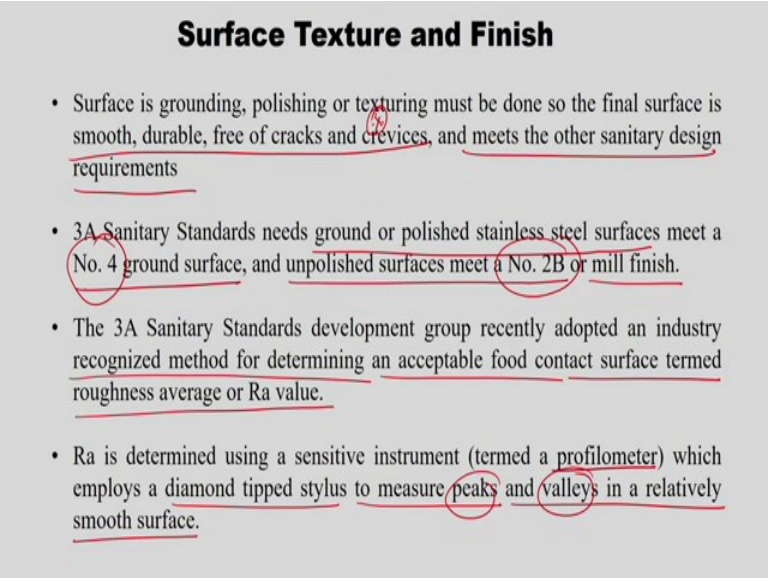
The other non-metallic food contacting surface materials are the ceramics, glasses, paper and wood. The ceramics are used primarily in membrane filtration system, so that we have seen and other limited applications are if wear resistance is necessary. And glass is also used as a food contact surface but the problem is breakage. Must be durable, break resistant or heat resistant

glass. So, to be used in the food contacting surface, the specially formulated glass materials, such as Pyrex, have proven it successful as a food contacting surface. Some applications where glass is used are light and sight openings, so to check what is happening inside in the vessels and in very limited glass piping applications.

Sometimes the glass piping column is also there. One of the applications we have discussed about the tracer particle inside the, tracer particle we are sending it to determine the velocity profile. In such cases, so we may go for the glass piping to see what is happening inside the piping system or vessels. And paper, the gasket material in piping system designed for daily disassembly and it is a single use material, so we cannot use it for continual usage.

And wood is highly porous and difficult to clean, so because of which it is not widely used and exception is what we have is hardwood cutting board, at kitchen. So, non-metal wise the plastics, rubber and rubber like materials and ceramics, glasses, papers and wood. Wood and paper are not mostly used, paper is a single usage material, wood is exceptionally we use it for cutting or any size reduction operations in the food processing place.

(Refer Slide Time: 41:57)



And the next one is surface texture and finish. The surface is grounding, polishing or texturing, so they must be done so that the final surface is smooth, durable and free of crack and crevices. So, this I talked about in even when we were discussing about the thermal processing equipments

itself. So, the equipment surface in which the food is contacting should be smooth, durable, free of cracks and crevices and meets also the sanitary design requirements.

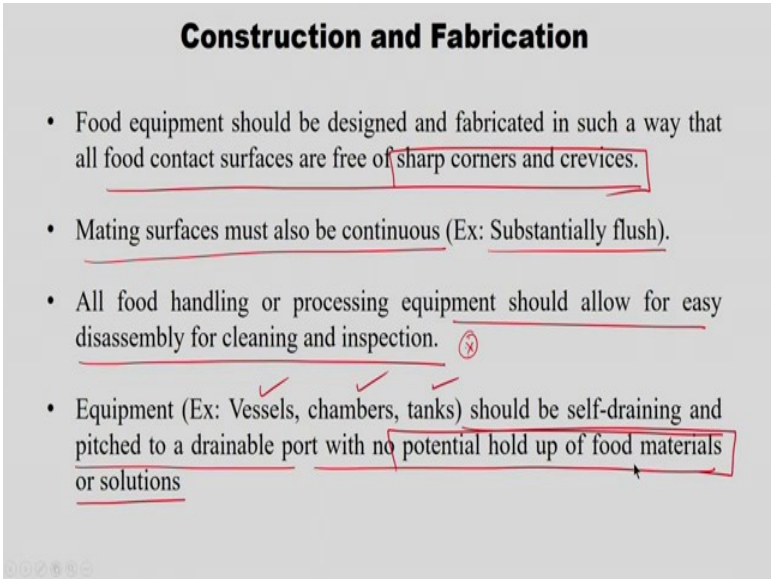
And 3A sanitary standards needs ground or polished stainless steel surfaces meet a number 4 ground surface and unpolished surfaces meet a number 2B or mill finish. So, the standards which talks about the polished stainless steel and unpolished one are, the polished one is number 4 and the unpolished one is number 2B.

The 3A sanitary standards development group, recently adopted an industry recognized method for determining an acceptable food contact surface termed roughness average or Ra value. So, we are telling that like the surface should be smooth, what is the parameter to check whether the surface is smooth or not, so this 3A sanitary standards development group, so they came up with the recognition method. So, that is nothing but here the 3A sanitary standards development group came up with a method to determine the acceptable food contact surface, so in terms of roughness average or Ra value.

So, Ra is determined using a sensitive instruments, which is nothing but a profilometer, which employs a diamond tipped stylus to measure peaks and valleys in a relatively smooth surface. So, the 3A sanitary standards development group, developed a method, so to check for acceptability of food contact surface whether that is smooth or not, so that factor is nothing but or the method is nothing but the roughness average or Ra value method.

So, this Ra value is determined by sensitive instrument, which is nothing but a profilometer, so which employs a diamond tipped stylus to measure peaks and valleys, so if there are any peaks and valleys so that means the surface is not a smooth one. So, we can directly get to know from the roughness average or Ra value, which is measured by profilometer.

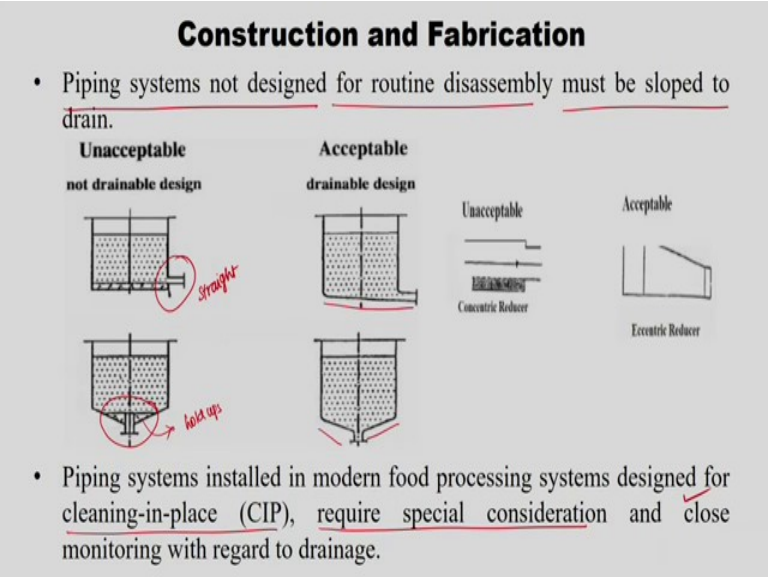
(Refer Slide Time: 44:37)



Then the construction and fabrication. The food equipment should be designed and fabricated in such a way that all food contact surfaces are free of sharp corners and crevices. So, this also we have discussed. In terms of pressure also, we should avoid the sharp corners and crevices. The mating surfaces must also be continuous, so to give substantially flush. And all food handling or processing equipment should allow for easy disassembly for cleaning and inspection, so this also we discussed enormously in most of the lectures.

And equipment should be self- draining, the vessels, chambers and tanks and pitched to a drainable port with no potential hold up of food materials or solutions. So, this we discussed in the pasteurization also, there should not be any food chunk, that is why the holding tube is sloped, it is not a horizontal one, it is a sloped tube. So, here the equipment should be self-draining and pitched to a drainable port with no potential hold up of food material or solutions.

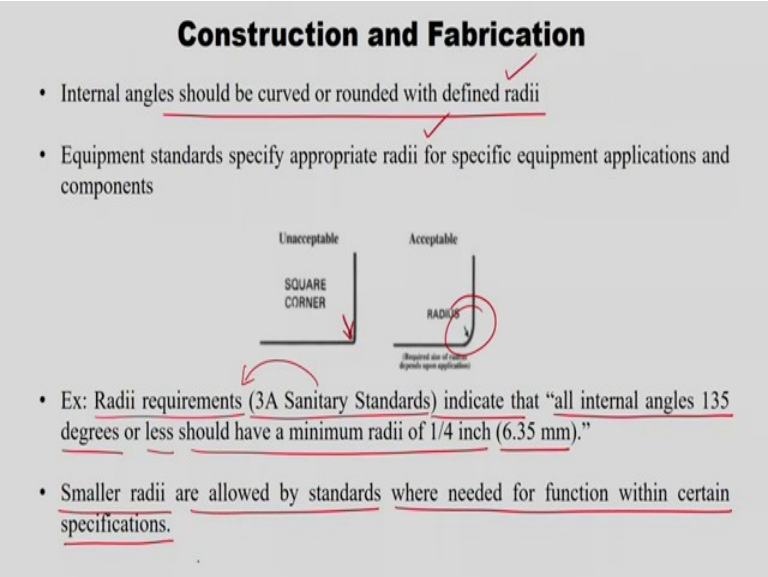
(Refer Slide Time: 45:46)



So, these are all certain diagrams or pics to get to know which one is acceptable and which one is not acceptable. The piping system not designed for routine disassembly must be sloped to drain. So, the piping system not designed for routine disassembly must be sloped to drain. So, one such example is your holding tube, in sterilization operation or pasteurization operation, so the unacceptable designs are these one. So, here you are not getting the direct draining and here the design is in such a way that you may get some hold ups of the material, so this is straight one.

So, the acceptable designs are the sloped one, so here also the sloped one and the piping system installed in modern food processing industries designed for a cleaning-in-place, CIP technique, require special consideration and close monitoring with regard to drainage. So, this also in certain lectures I have discussed, even though there is a technique CIP, clean-in-place, so if the particular surface needs proper cleaning or to be taken care especially then we apply the manual cleaning there or even after CIP is done, then there is a extra care or monitoring with regard to drainages required and also check whether that particular surface is cleaned properly or not.

(Refer Slide Time: 47:28)

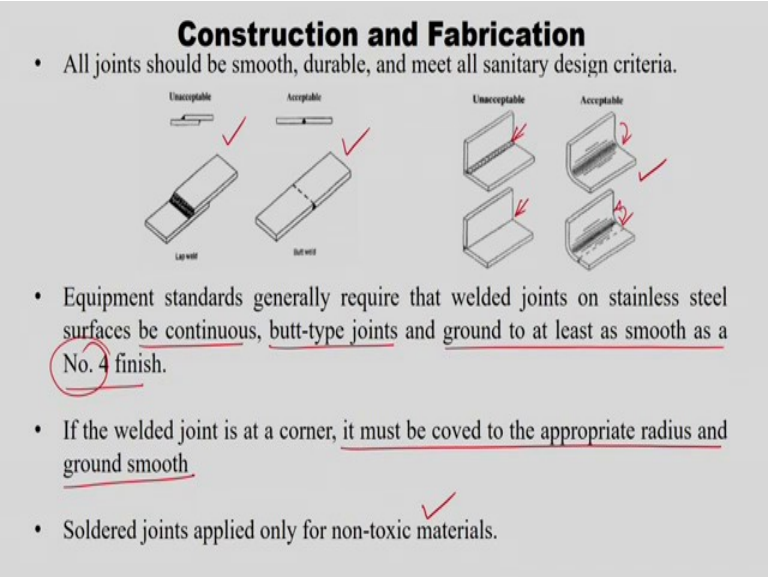


Then the internal angles should be curved or rounded with defined radii, so here it is nothing but a square corner, sharp edges, so that should be avoided, it should be of particular radii. So, the curved means which angle or which radii it should be curved, so that is what that defined radii.

The equipment standards specify the appropriate radii for specific equipment applications and components, so based on a specific equipment application and components, so this radii is defined by 3A standards. So, the radii requirements, 3A standards requirements are suggested by 3A standards, indicate that all internal angles should be of 135 degree or less should have a minimum radii of 1 by 4^{th} inch, so that means 6.35 millimetre.

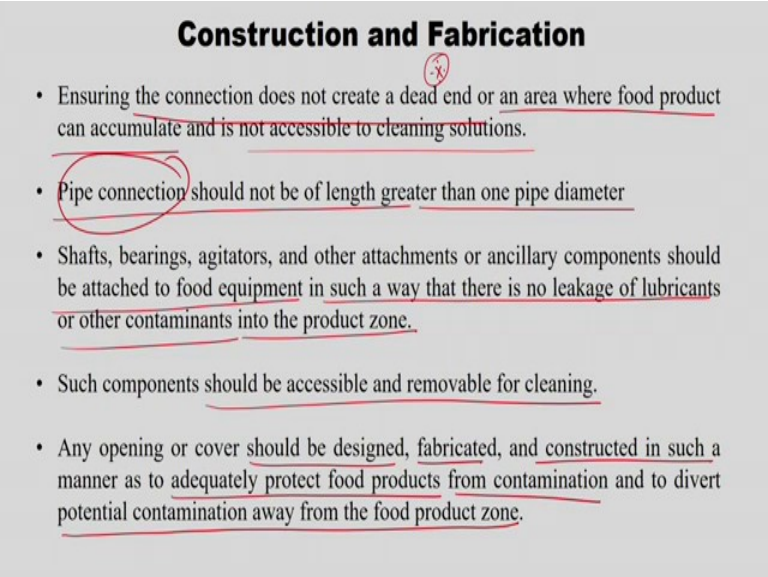
Smaller radii are allowed by standards where needed for function within the certain specifications. So, most of the time we should go by the radii requirements which is given by 3A sanitary standards but whether any certain applications or certain requirements needed, then we should go for smaller one. So, if it given as 1 by 4^{th} inch, so the allowed one is less than that, not more than that. The smaller radii are allowed by standards where needed for function within the certain specifications.

(Refer Slide Time: 49:04)



And all joints should be smooth, durable and meet all sanitary design criteria, so one such is the unacceptable one is lap weld, acceptable one is butt weld. And here in the joints there should not be any sharp ends, so it should be also coved, so this is acceptable one. And equipment standards generally require that welded joints on stainless steel surfaces be continuous, butt-type joints and ground to at least as smooth as a number 4 finish, number 4 finish is again standard to be used in welding practices. +If the welded joints is at a corner, it must be coved to the appropriate radius and ground smooth, so this is what I told. And soldered joints applied only for non-toxic materials, otherwise it is not preferred method of construction or fabrication.

(Refer Slide Time: 49:59)

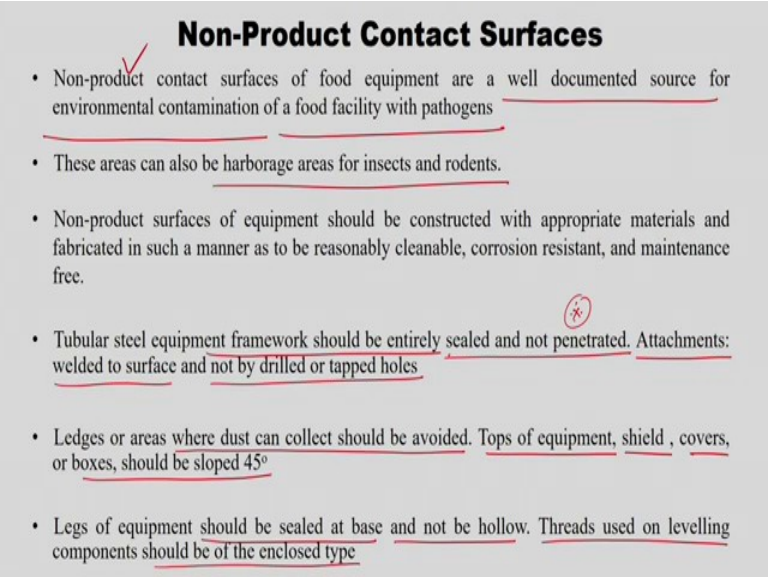


Ensuring the connection does not create a dead end, so we should also be careful about the connection does not create a dead end or an area where the food product can accumulate and is not accessible to cleaning solutions. So, this also we discussed in the dryers, the food contacting surfaces should not have any crevices or cracks or pits. And pipe connection should not be of length greater than one pipe diameter. So, the pipe connection should not be of length greater than one pipe diameter.

The shafts, bearings, agitators, and other attachments or ancillary components should be attached to food equipment in such a way that there is no leakage of lubricants or other contaminants into the product zone, so that there should not be any leakage of lubricants or other contaminants. And such components should be accessible and removable for cleaning. And so any such things are happening, it should be cleaned then and there, so and also the equipment should give a room for such access.

And any opening or cover should be designed, fabricated and constructed in such a way that, they adequately protect the food products from contamination and to divert the potential contamination away from the food product zone. The cover, the sealing also should be done in such a way that it should protect the food products from contamination and to divert the potential contamination away from the food zone.

(Refer Slide Time: 51:43)

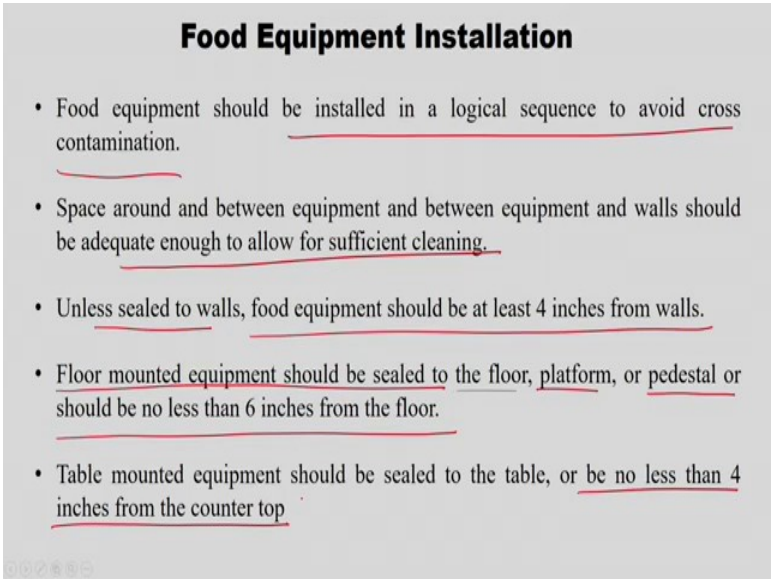


And non-product contact surfaces of food equipment are a well documented source for environmental contamination of a food facility with pathogens, so these are non-product contact surfaces. In the product contact surfaces, we have seen 2 varieties one is metals and another one is non-metals and we have also seen certain general standards and practices and guidelines used for construction and fabrication. So, now we are discussing about non-product contact surfaces, so these also well documented source for environmental contamination as well as the pathogens.

And these areas can also be harbourage areas for insects and rodents. And non-product surfaces of equipment should be constructed with appropriate materials and fabricated in such a manner as to be reasonably cleanable and corrosion resistant and maintenance free, so whatever we discussed till now that is also holds true for non-product contact surface.

The tubular steel equipment framework should be entirely sealed and not penetrated, so this is important. So, they should be sealed properly and if there are any attachments, they should be welded to the surface and not by drilled or tapped holes. And ledges or areas where dust can collect should be avoided in the non-product contact surfaces and tops of equipment, shield, covers or boxes should be sloped around 45 degree. The legs of the equipment should be sealed at base and not to be hallow and the threads used in levelling components should be of the enclosed type.

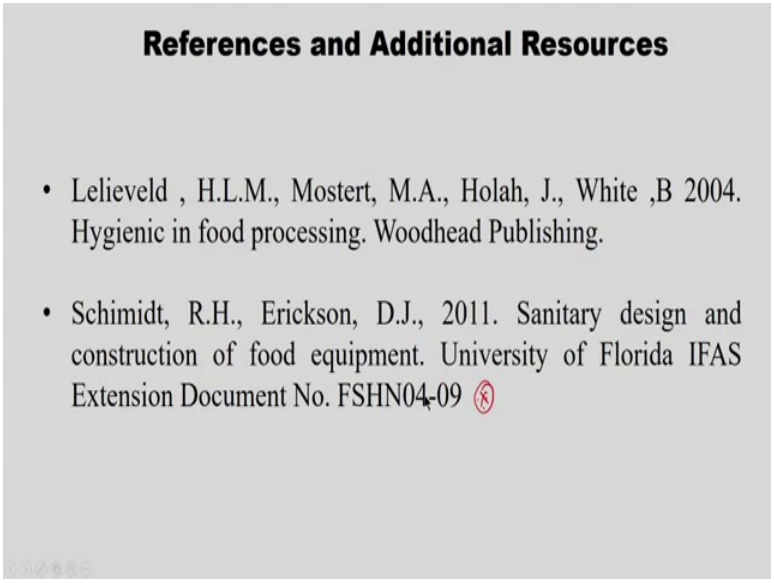
(Refer Slide Time: 53:31)



And finally the food equipment installation, so they should be installed in a logical sequence to avoid any cross contamination issue and the space around and between equipment and between equipment and walls should be adequate enough to allow for sufficient cleaning. Unless sealed to walls, the food equipment should be at least 4 inches from the walls. And the floor mounted equipment should be sealed to the floor, platform, or pedestal or should be no less than 6 inches from the floor.

So, they should be sealed to the floor and platform or pedestal or should be no less than 6 inches from the floor. And table mounted equipment should be sealed to the table or be no less than no less than 4 inches from the counter top. So, these are certain regulations and standards followed in a food equipment installation.

(Refer Slide Time: 54:33)



So, these are the references and additional resources, so most of the points were taken from this particular reference. And so here in the second part, first one we have discussed about the different sanitation related organizations and we discussed about what they were mainly working on and certain of their guidelines and practices along with the title, that you can access in their website itself because it will be very heavy to discuss each and every title.

And the second part of this lecture we have put the common guidelines, practices used in the food processing equipment. So, we have done as of different categories, one is on food contacting surfaces and food non-contacting surfaces. In food contacting surfaces, we have discussed about metals as well as non-metals. Then non-contacting surfaces also follow almost same but maybe little less strict guidelines which are used for the contacting surfaces. And also we discussed about the construction, fabrication of the food processing equipment and installation of the equipment. So, these are all general criteria, but if you get to know in depth about each and every standard, so you may refer into their particular website. Thank you.