LECTURE 23

COBALT 60 COMMERCIAL IRRADIATION FACILITIES

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Let us first discuss where the Cobalt 60 comes from.

Cobalt as an element has an atomic weight of 59. The Cobalt is mined from the ground machined down into small pellet sizes and then placed into a nuclear reactor. The pellets of Cobalt in the reactor are bombarded by neutrons, and eventually pick up an extra neutron into the nucleus of the Cobalt atom. This increases the atomic weight to 60, and the Cobalt is now Cobalt 60. However, the other neutrons and protons in the nucleus of the atom are not too happy about this intruder, and they set up a reaction to try and get rid of it, this reaction is in the form of Gamma and Beta rays. It should be understood that the Gamma rays that are emitted are deeply penetrating, but have insufficient energy to break into the nucleus of an atom. Thus Cobalt 60 cannot impart radio-activity to any substances exposed to it. The now radio-active Cobalt 60 slugs are removed from the reactor and encapsulated into stainless steel pencils. These pencils are approximately 18" long and ½" in diameter. The slug is double sheathed in stainless steel to ensure that it cannot under any circumstances be removed from the encapsulated pencil. The pencils are then placed into a source module, each module contains 22 source pencils. The modules are then arranged in a source rack. The size and configuration of the source rack differs for different types of applications.

The advantages of using Cobalt 60 for ionizing treatment are, that it has excellent penetration, in fact it takes up to 6' of concrete to stop the gamma rays omitted from a 2 million curie source. Gamma Plants are also very efficient, in as much as there is very little mechanical or electrical equipment involved or incorporated in a gamma irradiation facility, compared to that say of an electron accelerator machine, therefore there is less that can go wrong and the average efficiency of a gamma plant is usually around 95% of all available processing time. This advantage of course becomes critical when processing perishable goods. It would be a disaster if half way through processing a shipment of frozen prawns for example, the plant was to break down and not be able to resume production for a number of hours.

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There are of course disadvantages to using Cobalt 60. The major disadvantages are, Cobalt 60 is constantly decaying it loses its strength and therefore its throughput capabilities by 13% per annum. This decay is non-negotiable and occurs whether the Cobalt is being used or not. Another major disadvantage is that, at present there is really only one major supplier of Cobalt 60 in the world. That supplier is the Atomic Energy of Canada Ltd. This disadvantage has become very apparent over the last twelve months, as there has been an acute shortage of Cobalt 60, so much so that A.E.C.L. had all customers on an allocation system. This of course is not good for business. The last major disadvantage, and probably the greatest, is the fact that Cobalt 60 is a member of the nuclear family and no matter whether we call it irradiation, ionization, picowaves or whatever, there is no getting away from the fact that users of Cobalt 60 will be lined up with the nuclear industry, and as this is such an emotive issue these days no-one escapes from the stigma of Three Mile Island.

Let us now examine step by step the procedures that need to be carried out before a gamma irradiation plantcan become fully operational. The first action that needs to be taken, it to gather market intelligence or to determine the specific needs that a plant would service. This would include what products would be required to be processed and at what dose, making sure that the minimum and maximum dose was clearly defined. What size of units would the products be processed in, that is what are the size of the shippers and cartons to be used. We must then determine when they will be processed, some produce are seasonal and the demand on the plant may be subject to these seasonal variances. What quantity of product can we expect, this is probably the most important variance of all. Then we must decide where the plant will be located, this will influence the initial cost of purchasing land. We must also decide what size of land will be required, and it is at this stage that a decision must be made on how much warehousing you will have on your site.

Having gathered this initial market intelligence, you can now move on to the second step in the project, that being that you can now decide on what type and size of plant that would be required.

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There are two different types of plant design available. Both are similar in that they have a concrete shielding, a source pool to store the isotopes in when they are not being used, and the filtrating and de-ionizing systems are also identical. Where they differ, is in the method of moving the product through the source chamber. There are two different types of plants, a tote box plant and carrier plant. The tote box plant as its name suggest moves the product through in an aluminium box, whilst the carrier plant moves the product through in a long carrier suspended from the roof on a monorail. The tote box plant has greater cobalt efficiency and much better dose uniformity throughout the product. However, the plant is very inflexible and suited to a one dose application only, that is for instance processing medical products to a level of 25 k/grays consistently. The size of package or outer shipper that can be processed is limited to the size of tote box that is used, and this plant is therefore ideal for someone who has a captive product, that is an in-house application where they are only processing their own products, they can therefore control the size of shippers used. However, for a contract service facility a much more flexible approach is required and it is in this area that the carrier plant has become very popular.

Carrier plants like the tote box plants come in various sizes, from carriers 7' high to carriers 12' high that can contain or process full pallet loads of product. Although the carrier plant is not as Cobalt efficient as the tote box plant, it does give greater flexibility. Any contract facility offering the ionizing service must be expected to receive the products to be processed in any shape or size of weight. Although an ongoing effort is maintained to try and educate customers into using shipper sizes that will fit into the tote box or carrier exactly, most customers have their own idea of what size of outer shipper they will use. This is usua ly determined by the quantity of products that they are selling in each shipper. The carrier being much larger gives a greater flexibility for size of containers or shipper that can be processed. Also by the use of an incremental dose accumulation system, each individual carriers exposure time can be controlled, thus enabling each carrier to receive a different dose. Ansell International have both types of plants. In Melbourne and Malaysia we have the tote box irradiators, whilst our new plant which will come-on-stream in November this year, is a carrier plant.

Getting back to our market intelligence, we can determine what type of plant will need to be constructed to suit that specific application. For example, if the vast majority of product to be processed is medical products at 25 k/gray, then a tote box irradiator could be the type of plant that should be constructed. However, if there is a variety of products to be processed at a large variety of different dose levels, then it is obvious that the carrier plant would be the favoured facility to construct.

Again, referring back to our market intelligence data and by specifically looking at the size or volume of product and quantity of products that will be required to be processed, we can determine the size of plant that will be required, for example a one million, or a two million or even maybe a five million curie capacity facility.

Having decided on the size and type of plant that will be needed we must now come up with a cost. Let us look at the economic requirements. These fall into two areas, Capital items and Operating costs. The capital items are costs that will be initially incurred into constructing the plant. The operating costs are ongoing costs that must be met in order to process the products. Capital items would include the cost of land, the cost of an irradiation chamber and equipment, the cost of warehousing, the cost of administration offices, the cost of laboratories, the initial Cobalt 60 loading, the cost of plantand equipment such as forklift,trucks, conveyors, compressors, computers etc.etc. When all of these expenses have been totalled up, then that final figure will be the initial payout required to enable the project to go ahead. Operating costs must now be calculated, these include depreciation of plant and equipment, that is all the capital items mentioned before have depreciated over a certain amount of years. This depreciation time varies from item to item and is usually determined by corporate accounting policy. Other operating costs that need to be calculated are people costs, that is wages for indirect and direct employees, you must also add in the overhead costs such as overtime payment, payment set aside for sickness, payment set aside for tax etc.etc. Another major operating cost is Cobalt replenishment, as mentioned before the Cobalt is decaying at 13% per annum and an allowance must be made in your operating costs to cover the purchase of future Cobalt in order to maintain your throughput capabilities.

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There are other minor costs which go on an on, such as maintenance equipment, security, stationery, training costs, site charges such as telephones, power, water, rates and taxes as well as many many minor costs, including waste disposal, cleaning and protective clothing.

Over the years, Ansell have become very proficient at containing most of these costs, but that is something that only experience can teach you.

Having determined the cost to operate and pay for the plant and knowing the expected throughput, you can then determine the break-even minimum charge for processing products through the plant. If you wish to make a profit, then a profit margin is added to give the operating profit before tax (O.P.B.T or G.P.). It's at this stage that any sales and marketing expenses are deducted, for instance promotions,advertising any sales staff costs, brochures, travel or entertainment expenses. The marketing expenses are then deducted from the operating profit before tax figure thus giving a marketing profit. This is the bottom line, and it will show very quickly whether a construction and operation of a gamma irradiation facility is economically feasible or not.

Assuming the figures come out right, and funding is granted the next stage in the operation is to immediately take up an option on land purchase and it is at this point, that all regulatory authorities should be contacted and given a detailed specification of the facility that you wish to construct. The regulatory authorities will evaluate the specification and inform you if it meets the licencing requirements or not. Once approval has been received from the regulatory authorities, an application to develop the facility must be lodged with the local municipal council. The council will evaluate the application and once that they are satisfied that the plant is not a potential hazard to the safety, health and welfare of the municipalities residents, then the application for development will be approved. This part of the whole project is the most exhaustive and difficult part to complete. The local municipal council is made of residents from that area, these people are not physicists and have no experience of the ionizing energy process. They have been influenced by all the adverse publicity that has been given to nuclear power, including nuclear weapons over the years.

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It has therefore, been our experience that a great deal of careful education is required before the council members overcome their fears and suspicions. There are many pitfalls that can be fallen into during this phase of the project, and it is important that all facts and information regarding the application are given to the council members, and attempt to conceal any matter would be fatal at this time. Assuming the council is satisfied and deveopment application is approved a building approval must be given. This is usually carried out by local and state authorities and relates mainly to the construction design and materials used in the building of the facility.

The difficult part is now passed, and the next step is a normal construction project.Although nothing ever runs smoothly at least the problems that are met now are not unusual problems or problems that are specific to gamma plants, they are usually those problems associated with general construction work, and can be readily overcome.

Once the construction is well under way, it then becomes necessary to recruit and train personnel that will operate and manage the facility.Here it is advisable to co-ordinate with national and state authorities for advice. In N.S.W. we have been very fortunate in receiving sound advice from the radiation branch who have also offerred to conduct courses on occupational safety and health matters related to gamma irradiation plants. Special training will need to be given to the plant manager who will be the licensee of the facility, and he will need to demonstrate to the licencing authorities that he is fit and capable of being responsible for the facility. Training,of course,is also required in dosimetry processing, product handling, recording procedures and even in public relations and media contact.

The plant is then commissioned to ensure proper dose distribution and uniformity as well as all safety aspects are working perfectly. Once you have passed these inspections, you are now in the ionizing energy business, good luck!

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Ansell Internationals ionizing energy division have been in the contract service ionizing business for 40 years. The Melbourne facility was opened in 1971 and the Malaysian plant located in Melaka commenced operations in 1978. The brand new State of the Art carrier plant presently under construction here in Sydney, will be opened for business by the end of November this year. It is the divisions intentions to develop the business wherever there is an opportunity, and Ansell will be pursuing the expansion of its activities not only here in Australia, but throughout the Asian region. For example, a feasibility study is already underway for the construction of a plant in Queensland. Initial investigations are planned later this month for New Zealand. Further down the pipeline we see expansion in Malaysia and Thailand a distinct possibility.

During the last 14 years a great deal of experience and expertise has been gathered, commencing with the sterilizing of medical disposable products in the early days through to the present time where a wide range of products and applications are processed through the Ansell Plants. Some of the more unusual applications are, the processing of wine corks, beehive boxes, pharmaceutical raw materials, cosmetic powders, creams and gels. Agricultural peat soil, cut flowers for export, containers and plastic bags for fruit juices, tomato pastes, and dairy products. Feed stock for laboratory rats and mice, veterinary vaccines. The list goes on and on, and Ansell are constantly carrying out trials tests and research into the ionizing energy treatment of new products.

The company sees the treatment of food products by ionizing energy as the largest single growth potential for any of its products. We have already a list of potential customers who will begin to process food products as soon as approvals are received.

The company's success in constructing, operating and marketing a profitable gamma irradiation facility cannot be disputed and we would welcome the opportunity to work with any of the countries represented here to-day, with the mutual objective of establishing the commercialisation of the ionizing energy treatment of food.

Thank You.

GEORGE WEST
General Manager - Ionizing Energy Division.