SAFETY CONSIDERATIONS IN AQUEOUS REPROCESSING PLANT OPERATIONS

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PHILLIPS PETROLEUM COMPANY

ATOMIC ENERGY DIVISION

NATIONAL REACTOR TESTING STATION
US ATOMIC ENERGY COMMISSION
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ABSTRACT

Safety precautions utilized for control and confinement of fissionable and radioactive materials in the various aqueous reprocessing operations performed at the Idaho Chemical Processing Plant are presented. Three primary nuclear safety controls, geometrical, mass limitation, and concentration control, are used. Operations are performed according to standard operating procedures which are set up to prevent circumvention of the primary nuclear safety controls. The various processing operations with their particular safety features are discussed. The operations include: (1) receipt, handling, and storage of irradiated fuel elements; (2) dissolution of the fuel elements in various reagents; (3) separation of the unburned fissionable material from fission products and fuel element structural materials by solvent extraction; (4) salvage or recycle operations of off-specifications product or waste solutions that exceed the disposable fuel concentration limits; (5) product packaging, storage and shipment; (6) fission product recovery; and (7) waste collection, handling and disposal. The original plant design and later additions and modifications included built-in geometrical control wherever practical with allowances for possible neutron interaction between vessels. The standard operating procedures specifically state mass limits and concentration controls required for certain operation which involve appreciable quantities of uranium. Administrative control insures compliance with the standard operating procedures.
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INTRODUCTION

The Idaho Chemical Processing Plant is designed to recover the unburned portion of irradiated nuclear fuels from various types of reactors. Aqueous reprocessing is used in all of the plant processes for decontamination and recovery of the fissionable materials. The plant is located at the National Reactor Testing Station near Idaho Falls, Idaho, and is operated for the AEC by Phillips Petroleum Company.

The Idaho Chemical Processing Plant (ICPP) operations may be divided into several individual steps: (1) receipt, handling, and storage of irradiated fuel elements; (2) dissolution of the fuel elements in various reagents; (3) separation of the unburned uranium from fission products and fuel element structural materials by solvent extraction; (4) salvage or recycle operations of off-specification product, or waste solutions that exceed the disposable fuel concentration limits; (5) product packaging, storage and shipment; (6) fission product recovery; and (7) waste collection and disposal. The ICPP was the first AEC reprocessing facility designed for direct maintenance. Design of the original plant and of later additions and modifications carefully evaluated all foreseeable nuclear and radiation hazards for each of the processing steps.

Three primary controls are used to prevent nuclear incidents within the ICPP: (1) Geometrical -- wherever practical, vessels are designed to be geometrically safe under process conditions; (2) batch or mass limitation -- a
limit is placed on the quantity of uranium that may be contained in a vessel or cell; and (3) concentration limit -- this control is used in conjunction with batch limitation and places a limit on the quantity of uranium per unit volume in a vessel. In processing aluminum alloy fuels, an additional safety factor or an indirect concentration control is provided by the presence of the aluminum, i.e., the quantity of aluminum present and its solubility limit as the nitrate salt limits the uranium concentration possible to less than the theoretical minimum critical concentration. This is true for a wide range of aluminum alloy fuels processed at ICPP.

Operating experience has proved that the ICPP basic plant design and nuclear safety control procedures are sound; however, administrative control is necessary to insure compliance with limits on mass and concentration and established operating procedures for safe operation of the ICPP.

RECEIPT, HANDLING AND STORAGE OF IRRADIATED FUEL ELEMENTS

Incoming irradiated reactor fuel is stored in an underwater storage basin in discrete quantities which are arranged in critically safe arrays. A plan view of such storage facilities is shown in Figure 1. Mechanical spacers built into the basin and equipment maintain safe separation in all storage and handling operations except cask unloading (or loading) and transfer to storage buckets. Administrative control is required in the unloading and transfer operations to prevent unloading fuel elements on top of others or of placing filled storage buckets close together in a moment of forgetfulness. Time in storage depends on process scheduling or until certain radioactive constituents decay to tolerable levels; fuel elements are cooled at least 120 days before processing.

Fuel is unloaded underwater from the shipping casks in one of two transfer areas. Usually the fuel in the casks is in removable "buckets" which are con-
FIGURE 1
SCHEMATIC FUEL HANDLING
AND STORAGE FACILITIES
constructed to limit the uranium mechanically to a safe unit. If necessary, fuel is transferred from individual shipping buckets to storage buckets at the central transfer pit. Storage buckets are suspended on hangers from an overhead monorail and are transferred by means of the monorail system to specific locations in the storage basin. Mechanical spacers on the hangers and the position of the monorail provide for a safe two-foot center-to-center spacing arrangement between storage buckets. No accidental rearrangement in this spacing is possible. A minimum of fifteen feet of shielding water covers the fuel elements in the buckets at all times.

Mechanical treatment may be required prior to processing. For example, removal of end sections from certain fuel elements may be required to facilitate processing. Dry caves are used for any necessary mechanical treatment at the ICPP. Provisions are made in the dry-cave operating procedures to guard against accidental stacking of fuel pieces or segments in unsafe arrays, or accidental flooding. Mechanical treatment may alter the size and shape of the fuel. These changes are considered in establishing the mass limits for the cave. Mass limits for safe storage of the unaltered fuel elements may differ considerably from safe mass limits after mechanical treatment.

Special charging casks carried by a conventional straddle carrier are used for transferring safe amounts of fuel from storage to process. Fuel is charged directly into a batch dissolver by positioning the cask over a charging chute and removing a drawer at the bottom of the cask to permit the fuel to drop directly into the dissolver. If there is more than one dissolver, provisions must be made against "double batching" (putting two successive charges in the same dissolver). A system of timelocks on the charging chutes helps prevent double batching at the ICPP.
The two continuous dissolvers at the ICPP are charged with a master-slave manipulator from a dry charging cave. The charging cave, as shown in Figure 2, is not geometrically safe. A mass limit is established for each type of fuel that can be present in the cave. The limit is based on the dry minimum critical mass for the particular fuel. Administrative controls are required to enforce the limit on number of fuel pieces or elements in the cave as well as to prevent flooding the cave while in use.

Fuel handling operations are performed under strict radiation protection regulations. Constant air monitors in conjunction with radiation monitors are provided at various locations in the storage building. Portable monitors with alarms are used in the transfer area and with the straddle carrier. All fuel handling and transfer operations are under direct surveillance by health physics personnel.

DISSOLUTION OPERATIONS

The first unit operation after cooling and possible mechanical treatment is dissolution of the fuel in acid. Aluminum alloy fuels may be dissolved in either batch or continuous dissolvers, but zirconium and stainless steel fuels are dissolved batchwise only. Aluminum and zirconium fuel alloy batch dissolvers used at ICPP are not geometrically safe. The aluminum alloy continuous dissolvers and the stainless steel fuel batch dissolver are geometrically safe for the particular fuels processed. Allowances are made in the design of the dissolvers for precipitate formation unless it is known that precipitation cannot occur. All three primary controls (geometrical, mass and concentration limitation) are used in the dissolver operations. The nuclear safety controls for these operations are based on the most reactive fuel arrays possible and liberal safety factors are applied.
FIGURE 2
DRY CHARGING CAVE AND CONTINUOUS AL-U ALLOY DISSOLVER
The two continuous dissolvers for aluminum alloy fuels are limited by geometry as well as by indirect concentration control from the high percentage of alloying aluminum. Fuel is charged to a dissolver (also shown in Figure 2) from the dry charging cave at a semi-continuous rate such that an 8-12 foot depth of material is maintained in the dissolver. Construction of the charging chute limits the metallic fuel elements or segments to the lower critically safe portion of the dissolver. Acid and catalyst are added continuously to the dissolver to produce a continuous overflow of product from the dissolvers. The expanded diameter reflux section on the dissolvers is not limited by geometry; however, the overflow line prevents dissolver solution from rising into the reflux section. If the overflow line should plug or a downstream valve be closed by accident, the uranium concentration in the solution would still be less than the limiting critical concentration by virtue of the aluminum present.

The material balance is such that the usual uranium concentration in the dissolver product is about 2 gm./l. A high acid deficiency could result in a concentration of about 5 to 6 gm./l. but would require several hours of maloperation. Also, saturation of the dissolver solution with aluminum nitrate would prevent buildup of a higher uranium concentration. The estimated maximum concentration possible would still be only about half of the limiting critical concentration.

A sketch of an aluminum alloy batch dissolver is shown in Figure 3. Fuel is charged through the charging chute to the perforated basket inside the vessel. Nitric acid and mercuric nitrate catalyst are added through lines which enter at the top of the vessel. An air sparger is provided for agitation if desired. The bottom one-third of the vessel is jacketed for heating and cooling as necessary. Batch or mass limitation is the primary control for the batch.

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FIGURE 3

BATCH DISSOLVER FOR Al-U ALLOY FUEL ELEMENTS

OFF-GAS LINE
TYPICAL PROCESS LINE
PERFORATED CRIB

SLUG CHUTE

HEATING OR COOLING JACKET

3'

5'8"

2'6"

4'2"

10"
dissolvers. A safe batch for each fuel type in the appropriate dissolver has been established from: (1) minimum critical mass of the metallic fuel in water, and (2) minimum critical mass for homogenous uranium-water solution in a water-reflected vessel similar to the dissolver. Generous safety factors are applied to the actual critical quantities. The fresh batch charge, the estimated "heel" (undissolved fuel portion from the previous batch), and the statistical uncertainty in these measurements are continually under surveillance. To assist control over double batching, a system of time locks has been installed on the fuel charging chutes.

For a particular aluminum alloy fuel, about 3.4 kg of U-235 is the minimum critical mass for an optimum array in water. Approximately 2.4 kg of U-235 is the minimum critical mass (estimated from experimental data) for an aqueous homogenous solution in a batch dissolver-sized vessel. Maximum safe dissolver content is, therefore, theoretically between 2.4 and 3.4 kg U-235 since there is uranium in solution at less than optimum concentration and metallic fuel present at other than optimum array. A safe working limit on the batch dissolver for this fuel has been set at 2.4 kg U-235 with an additional limit that not more than 1.0 kg be in solution. The undissolved portion in each batch must be determined precisely to maintain nuclear safety control. The heel cannot be determined directly, but is calculated from the amount of fuel charged and from the volume and uranium concentration of the dissolver product. Uncertainties in the measurements of these values must be considered statistically(1). For example, if after forty charges of 800 gm. U-235 each, the apparent heel exceeds 1.6 kg U-235 and 2.4 kg is the maximum allowable uranium content, then another 800 gm. batch cannot be charged. It is then necessary to make a heel clean out. The heel determination is set up so that the probability of exceeding

the 2.4 kg limit is considerably less than one in 10,000. Heel clean outs consist of making successive dissolutions without addition of fuel until less than one gram of uranium is dissolved in a batch. The dissolver is then assumed empty and the entire procedure started again. Procedures for zirconium and stainless steel fuels are similar; however, the numbers involved are quite different because of the difference in fuels and dissolver equipment.

EXTRACTION OPERATIONS

The separation of uranium from the fission products and alloying metal is accomplished by continuous liquid-liquid extraction. The process recovers over 99.0 percent of the uranium and produces a product essentially free of plutonium and with a fission product activity level that permits further processing without shielding. Three extraction cycles are normally required for adequate decontamination. Tributyl phosphate (TBP) dissolved in kerosene is used as the selective solvent in first cycle extractions. Hexone is used in the second and third cycles as the selective solvent. All three nuclear safety controls (geometrical, mass and concentration limitation) are utilized in the extraction operation which includes feed preparation and product evaporation.

Tanks, not geometrically safe, are used for collection of dissolver product and adjustment to a composition suitable as feed for the extraction columns. Batch limits are set on all of these tanks except for the continuous dissolver run tanks which are under concentration control. Batch limits are relatively easy to control in that only one dissolver batch at a time is transferred to the tanks. Administrative control over the dissolver batch extends to these tanks as well as to regulating all transfers in collection and adjustment tanks. The dissolver product is sampled from these tanks for the plant U-235 input measurements. The analytical results are used also in heel buildup calculations.
(batch dissolvers) as well as for making adjustments in preparing feed for the extraction columns.

Suitable safeguards or provisions must be made to assure that uranium will not precipitate either from evaporation or addition of reagents. These considerations are used in establishing batch limits on the dissolvers. Limits are usually set low enough such that there is little possibility of a nuclear incident resulting if a slurry or a concentrated uranium solution is transferred to a tank where a critical slab geometry can result. Occasionally uranium-rich recycle solutions are transferred into the adjustment or feed collection tanks. These transfers are batch limited and are under strict administrative control supplemented by a system of valve lockouts.

Formation of precipitates is much more likely in the zirconium and stainless steel fuel processes than in the aluminum process. Indirect concentration control by saturation of the solution with salts of the alloying metals is not practical in the zirconium process as a basis of nuclear safety control. Strict control of the batch limit is maintained through the feed adjustments and extraction operation by control over the charge to the dissolver and usual heel buildup. Diluents are added to the adjustment vessels before transferring uranium solutions into the vessels to provide immediate dilution. Air spargers are in operation before and during the transfer to provide immediate mixing. These precautions could prevent a critical concentration even if a gross error were made in the batch limit.

A TBP first cycle schematic is presented in Figure 4. Uranium is preferentially extracted in the 1A column from the headend evaporator product into the TBP-kerosene solvent, leaving the bulk of the fission products and aluminum in the aqueous phase, which is removed as raffinate. The organic solvent, rich in uranium, is scrubbed in the 1B column with aluminum nitrate scrub solution.
FIGURE 4
Schematic of TBP First Cycle Extraction for Aluminum Alloy Fuels

CPP-S-1385
for additional fission product removal. The scrub stream is recycled through the headend evaporator and 1A column for recovery of any uranium which may have back extracted into the aqueous phase. The scrubbed solvent is then contacted in the 1C stripping column with water which back-extracts (strips) the uranium into the aqueous phase. The aqueous phase then flows to the 1D column and the organic phase goes to the solvent recovery system. In the 1D column the aqueous phase is washed with fresh kerosene to remove TBP decomposition products. The washed aqueous phase then flows to the first cycle product evaporator for concentration to 1.5 molar uranium for feed to the next extraction-stripping cycle. Concentration limitation is the primary nuclear safety control for this operation. Safe concentrations are maintained by the normal column operating conditions. Abnormal operating conditions could result in a concentration increase to dangerous levels.

Dissolver solution from the first-cycle feed tank is mixed with the 1B column scrub solution and adjusted by evaporation in the geometrically safe headend evaporator to process feed specifications. Solid aluminum nitrate would plug the evaporator in event of maloperation and limit the uranium concentration to about one-half of the theoretical minimum critical concentration.

The 1A column is not geometrically safe in design. Feed is received directly from the headend evaporator and uranium concentration is limited by indirect concentration control to a maximum of about 5 gm./l. If the organic flow to the column is lessened, uranium concentration could conceivably rise to the equilibrium concentration of approximately 14.2 gm./l. The uranium content of the organic phase is limited by the TBP content. Saturation of the TBP-kerosene phase would result in a uranium concentration of approximately 18.9 gm./l at the top of the column. The interface controller in the expanded top section of the column is set to limit the organic depth to eight inches.
maximum, which is well below the critical height range for the concentrations involved. The controller has an audible alarm to warn of maloperation. For the uranium concentration to increase to 12 gm/l., the organic flow rate would have to diminish drastically and remain undetected for 2-1/2 hours. This is a minimum time as it is based (1) on the assumption of total extraction on first contact, and (2) no allowance for buildup of uranium in the 10-inch section of the column. The interface controller would have to fail and remain undetected simultaneously with the decreased solvent flow for potentially dangerous conditions to result. Operating procedures insure that neither of these abnormal conditions will remain undetected for over one-half hour periods.

The 1B column organic phase uranium content could rise to approximately 14.2 gm/l. in event of maloperation of the 1A column. The maximum aqueous phase concentration resulting from this condition (with normal scrub) is estimated as only 4.0 gm/l. Loss of scrub solution salting strength, however, would result in back-extracting uranium into the aqueous phase. The scrub solution stream has a specific gravity monitor which alarms if water or scrub low in aluminum nitrate is accidentally fed to the column. The expanded end section interface control and alarm is similar to that for the 1A column.

The 1C or stripping column is the most sensitive with respect to nuclear safety because of the high distribution coefficients. The column is diameter limited and the bottom is height limited for concentrations up to 48.8 gm/uranium/l. Allowance for interaction with the 9-inch diameter column was made. Should the interface controller alarm fail and the aqueous strip solution flow to the column diminish drastically at the same time and remain undetected for two hours, the uranium concentration in the aqueous phase could increase to 48.8 gm/l. concentration. Adequate strip solution is necessary to control the uranium concentration. The strip solution flow recorder is equipped
with a low-flow alarm to provide an audible indication of maloperation. Determination of the two-hour time required to build up to dangerous uranium concentrations also assumed complete stripping on first contact and again made no allowance for increasing the uranium content in the column itself.

The ID column is infinitely safe; however, the beaver-tail base is height limited on the same basis as the IC column. No extraction is possible in the ID column since the organic phase contains only traces of TBP. Uranium concentration cannot increase above normal unless the IC column malfunctions; two errors must occur simultaneously for this to happen.

Stream flow rates of the extraction systems are checked at frequencies based on the calculated time required to build up to potentially dangerous concentration levels in event of abnormal conditions. Regardless of the build up time, normal operating practice requires rate checks and recording of operating data at regular intervals.

The first cycle product evaporator, shown in Figure 5, concentrates uranium from 4 to approximately 350 gm/l. As shown this evaporator is geometrically safe except for the expanded vapor disengaging section. Overflow lines prevent accumulation of liquid in the expanded section.

Occasionally, because of difference in capacities, the first cycle product has to be stored temporarily prior to subsequent processing. Geometrically safe tube banks similar to those shown in Figure 6 are used for this interim storage. Safe tube banks are made of 5-1/4 inch O.D. tubes rigidly secured on 2-foot centers. A minimum 10-foot separation is required between safe tube banks at the ICPP.

The second and third cycle extractions are performed in geometrically safe equipment utilizing a hexone solvent. Geometrically safe equipment includes the continuous-feed storage, extraction, waste collection, and product evaporation and storage equipment.
FIGURE 6

Geometrically Safe Tube Banks Used for Storage of Concentrated Enriched Uranyl Nitrate Solutions
URANIUM SALVAGE

Process waste solutions high in uranium are collected in the salvage cell in geometrically safe banks, sampled for uranium content as a nuclear safety precaution, and then concentrated to minimum volume in a batch evaporator. The batch evaporator is not geometrically safe, but is batch limited. Concentrate is stored in a geometrically safe bank and recycled to solvent extraction feed as convenient.

Processing of salvage material is specifically outlined in the Standard Operating Procedure (SOP) manual, as are all other operations. A daily operating log is maintained as well as a daily shift-end status for the succeeding shift and the Operations superintendent. During periods of relative inactivity, the salvage operation procedures call for routine sampling, flushes with nitric acid, and solution transfers to prevent an accidental accumulation of uranium or uranium-containing solutions. All salvage operations are designed such that analytical results of representative samples are known before any transfers can be made and operations started. The system of lockouts insures that all transfers will be approved by at least two people (operator and a responsible supervisor). All salvage operations involve concentration control and batch limits which are less than the minimum critical mass for optimum conditions.

PRODUCT STORAGE AND SHIPMENT

The final product is highly concentrated enriched uranyl nitrate solution which is collected and stored in geometrically safe tube banks. When sufficient quantity has accumulated, it is loaded into "bottles" for shipment. The bottles (six-inch diameter, cadmium plated cylinders) are geometrically safe in themselves; however, to guard against interaction they are placed in "birdcages" to provide a minimum safe spacing between bottles. Birdcage refers to the outer
container of framework construction which surrounds and rigidly centers a vessel which actually contains the fissible material. As the product bottles are filled and placed in birdcages (Figure 7) they are transferred in lots of five to the product vault where they remain until enough have accumulated to warrant a shipment. The rows of birdcages must be separated by at least five feet. This requirement is enforced by physical barriers in the vault. Every operation with the final product is completely adaptable to geometrical control. Operators are thoroughly trained in product room procedures and are not switched around to other jobs.

The filling and handling operations follow a standard operating procedure which specifies the exact location of all bottles in the product room. The product room is divided into areas and a filled bottle can be moved from one area to another only if the previously filled bottle has been processed (sampled, weighed, and monitored for external activity) and stored in a birdcage. AEC Security assumes responsibility for the product upon loading into a truck for transfer to "the customer" either by public or private carrier.

A sample from each product bottle must be held until agreement in measurement has been reached with the customer. The samples (about thirteen grams each) are stored in a cabinet with cadmium spacers according to prescribed storage rules.

WASTE COLLECTION, EVAPORATION AND STORAGE

Liquid and gaseous wastes generated at the ICPP are classified according to the activity levels. Normally wastes do not contain any significant quantities of uranium. Waste stream which could contain appreciable quantities of uranium because of maloperation, such as second and third cycle extraction column.
FIGURE 7

Product Bottles and Birdcages Used for Shipping Enriched Uranyl Nitrate Finished Product
raffinates, are collected separately in geometrically safe banks and sampled before transfer to large volume temporary storage tanks. Feed for the second and third cycle extraction columns can contain as high as 350 gm. uranium/l. If aluminum nitrate salting strength is lost through maloperation, the uranium would go with the raffinate stream and waste collection in geometrically safe banks is required. Reliable continuous uranium monitors on the raffinate streams could probably eliminate the need for collection in geometrically safe banks. If no uranium is present in waste streams, subsequent processing presents no criticality hazards. If uranium is present above predetermined limits, the waste is routed to salvage according to procedures for recovery of the uranium.

BUILDINGS, CELLS AND EQUIPMENT

The ICPP was designed for direct maintenance. Equipment insofar as possible is of simple design for ease of decontamination and repair. Economics of constructing and operating the plant prohibited designs that would be geometrically safe in all respects or one that would process completely batches that were less than minimum critical mass. Prevention of a nuclear or radiation incident at the ICPP is complicated by the large number of vessels and interconnecting piping. Also, all of the fuel processed to date has been highly enriched. Constant awareness of the potential danger by all personnel is therefore necessary to maintain nuclear safety in the ICPP operations.

Sensitive components are installed in pairs or provided with alternates so that failure of one part will not require a process shut down. Equipment with high maintenance requirements, such as metering pumps and samplers, is located in shielded cubicles outside the hot cells. The cells have a stainless steel wainscot and are equipped with spray nozzles to facilitate decontamination.
Process equipment is provided with solution addition lines from the cold areas and outlets to the waste systems for internal decontamination with chemical solutions.

The radioactive process and auxiliary equipment is shielded by cell walls of ordinary concrete or unit shielding of lead to reduce the radiation intensity to less than one mr/hour in areas where personnel may be or have access to during processing operations. All processing facilities, the fuel storage basin, and waste storage tanks are below grade level. Structures above grade contain no uranium processing equipment. Figure 8 shows a section through the process building.

The cell floors are pitched so that in event of a spill, flow is toward a geometrically safe sump equipped with a jet and an alarm, both automatically actuated by the presence of liquid in the sump. All cell floor sumps of process cells which contain uranium are jetted to geometrically safe banks on a routine basis to prevent the buildup of uranium on the cell floor in case of a spill or leak and simultaneous sump instrument failure. Cell floor drains are normally closed with the valves sealed.

One of the original cells was modified for the recovery of intensely radioactive fission product Ba-La-140 from short-cooled MTR fuel elements. This is the hottest operation in the entire ICPP. Extra thick radiation shielding, six feet of concrete, is required to reduce the radiation intensity to a tolerable level. A five-foot thick lead glass window provides shielding while enabling the operator to observe his operations. One average shipment of product from the facility contains about 20,000 curies of activity; however, this intense radiation lasts but a short time. The quantity of uranium involved in each operation is less than 200 gm., so there is no criticality hazard. Nevertheless, the uranium containing "by-product" is stored
FIGURE 8
SECTION THROUGH PROCESS BUILDING

CPP-S-1387
in geometrically safe banks for additional cooling before being processed
with the usual plant feed stream.

Neutron absorbing materials are not used as a primary nuclear safety
control at the ICPP; however, there are several applications of this principle
in the plant. Poison increases the margin of safety in these applications but
does not prevent the possibility of neutron interaction. The potential use-
fulness of vessels filled with neutron absorbers is well recognized, and
undoubtedly will be relied upon in the future as a primary control as more
and more experimental data are obtained.

ORGANIZATION AND RESPONSIBILITY

Figure 9 shows the organizational units within the Atomic Energy Division
of Phillips that are concerned with nuclear safety at the ICPP. Members of
the two committees are appointed by the Division Manager. All have technical
backgrounds and the majority are experienced in operations. One member is
on both the AED Nuclear Safety Committee and the ICPP Safeguard Committee; he
is also a member of the Industrial Nuclear Safety Group.

The AED Nuclear Safety Committee has direct responsibility for reviewing
any activity within the Division and approving or preparing new standards to
guard against the possibility of a nuclear incident. The chairman of the
committee is the manager of the Theoretical Physics and Applied Mathematics
Branch; members are from the Reactor Physics and Engineering, Reactor Projects,
and ICPP Technical Branches. The committee can have theoretical investigations
conducted to determine nuclear safety of various operations and proposals as
requested in writing by responsible supervisors. Proposals may be presented
by personnel of the Operating or Technical Branches or may originate within
the Committee.
FIGURE 9
ORGANIZATION FOR NUCLEAR SAFETY CONTROL
IDAHO CHEMICAL PROCESSING PLANT

PHILLIPS PETROLEUM COMPANY
ATOMIC ENERGY DIVISION
DIVISION MANAGER

ATOMIC ENERGY DIVISION
NUCLEAR SAFETY COMMITTEE
CHAIRMAN—MANAGER, THEORETICAL PHYSICS AND APPLIED MATHEMATICS BRANCH
MEMBER—REACTOR PHYSICS AND ENGINEERING BRANCH
MEMBER—REACTOR PROJECTS BRANCH
MEMBER—ICPP TECHNICAL BRANCH

ICPP PLANT SUPERINTENDENT
LINE SUPERVISION

ICPP SAFEGUARD COMMITTEE
CHAIRMAN—DIVISION CONSULTANT FUEL REPROCESSING
MEMBER—ICPP OPERATION BRANCH
MEMBER—ICPP TECHNICAL BRANCH
MEMBER—ICPP TECHNICAL BRANCH
The ICPP Safeguard Committee is responsible for a continuing review of all phases of the ICPP processing operations where nuclear or radiation hazards exist. Primary functions of the Committee are to review the adequacy of procedures and recommend changes when necessary to (1) minimize nuclear hazards, (2) prevent loss of fissionable material, and (3) prevent spread of radioactivity outside the process areas. The chairman of the ICPP Safeguard Committee is the Division Consultant on aqueous reprocessing. Membership at present includes, in addition to the chairman, a representative of the Operating Branch and two representatives of the ICPP Technical Branches. The Committee is free to call on personnel of operating or special or service groups within the Division for any assistance it may desire. Any proposed changes in equipment or procedures that concern nuclear safety in any manner are submitted to the Safeguard Committee prior to the weekly meetings for approvals. Processing plans for the coming week must be reviewed at the regular meetings and approved or rejected. Equipment changes and operating proposals may originate within the Committee or come from the Technical or Operating Branches. Development of suitable nuclear safety control procedures is a joint undertaking of the Operating Branch and the Safeguard Committee. Applying the procedures and maintaining nuclear safety in the plant operations is the Operating Branch responsibility. The Safeguard Committee is responsible for auditing plant operations for conformance to the procedures.

Activities and recommendations of the two committees are reported in writing to the Division Manager and other interested people. Recommendations of the committees may be overridden only by the Division Manager.
PROCEDURES

The basic document used by the ICPP Operating Branch is the Standard Operating Procedure (SOP) Manual. This manual details each step of operations in sequence such as preoperational check list, stream compositions, batch volumes, flow rates, etc. The procedures are modified as revisions or changes become necessary in the process or operations. New information on process conditions and nuclear safety control procedures which are adopted and recommended by the ICPP Safeguard Committee are immediately incorporated into the procedures. The SOP specifically states the criticality control precautions that must be taken for a particular operation such as dissolution, recycle or salvage material or product handling. For less sensitive operations, the procedures do not make a distinction between process control limits and criticality control limits. The SOP manual lists valves and jets that must be locked out and color coded for criticality reasons for the various operations. Administrative control procedure for unlocking these valves and jets when required are given.

Alarm-type instruments are installed and available at the ICPP to alert personnel and to record after-the-fact radiation levels. There are twenty emergency-type monitors, each containing a gold foil segment and a high level radiation film meter in addition to 69 personnel neutron detector film packs located at strategic locations throughout the plant area. Numerous area monitors and constant air monitors are available for positioning in sensitive plant areas as required by Health Physics. All ICPP personnel wear the usual beta-gamma radiation film meter in their exchange badge. All personnel exchange badges contain indium foil segments for prompt identification of highly exposed personnel in event of a nuclear incident. Personnel performing certain operations or located in certain areas also wear dosimeters for a daily check by
ICPP Health Physics on radiation exposure. AEC personnel are responsible for reading the film badges at regular intervals and for maintaining the employee's permanent exposure records. ICPP Health Physics also maintains personnel exposure records and may request that the AEC read a particular person's film badge at any time. Sixteen neutron threshold detectors are located throughout the plant area to provide data for the neutron spectrum in event of a nuclear incident. Calibration of body fluids for absolute determination of exposure requires incident neutron spectrum and gamma-neutron dose ratio data. Body fluid samples are taken on a routine basis -- one-to-four per year for all personnel as determined by the probability of exposure. Special samples may be requested if there is the possibility of ingestion or exposure to air-borne materials. There is an established evacuation procedure in event of an emergency. All personnel are familiar with alarms and evacuation procedures. Drills are held frequently.

Operator training and supervision are a very important part of the ICPP nuclear safety program. The human factor must be considered at all times. Regardless of training, ability, procedures or experience, the human factor will show up in some unexpected incident or place and usually when least expected. The most common error is in assuming rather than verifying. Sometimes, even the best trained operator may open the wrong valve, confuse two samples, neglect a routine check point, make an arithmetical mistake, make an error in judgment, etc. At the ICPP, intensive operator training is conducted at every opportunity. This training has resulted in an operator competence well above that in ordinary industry.

In general, a comprehensive evaluation of possible nuclear safety hazards during process and equipment designs, the continuing review of proposed and existing processes, procedures, and equipment by the Operating Branch and the
ICPP Safeguard Committee, and the strict adherence to the approved Standard Operating Procedures by operating personnel have all combined to produce a high level of nuclear safety in the ICPP.