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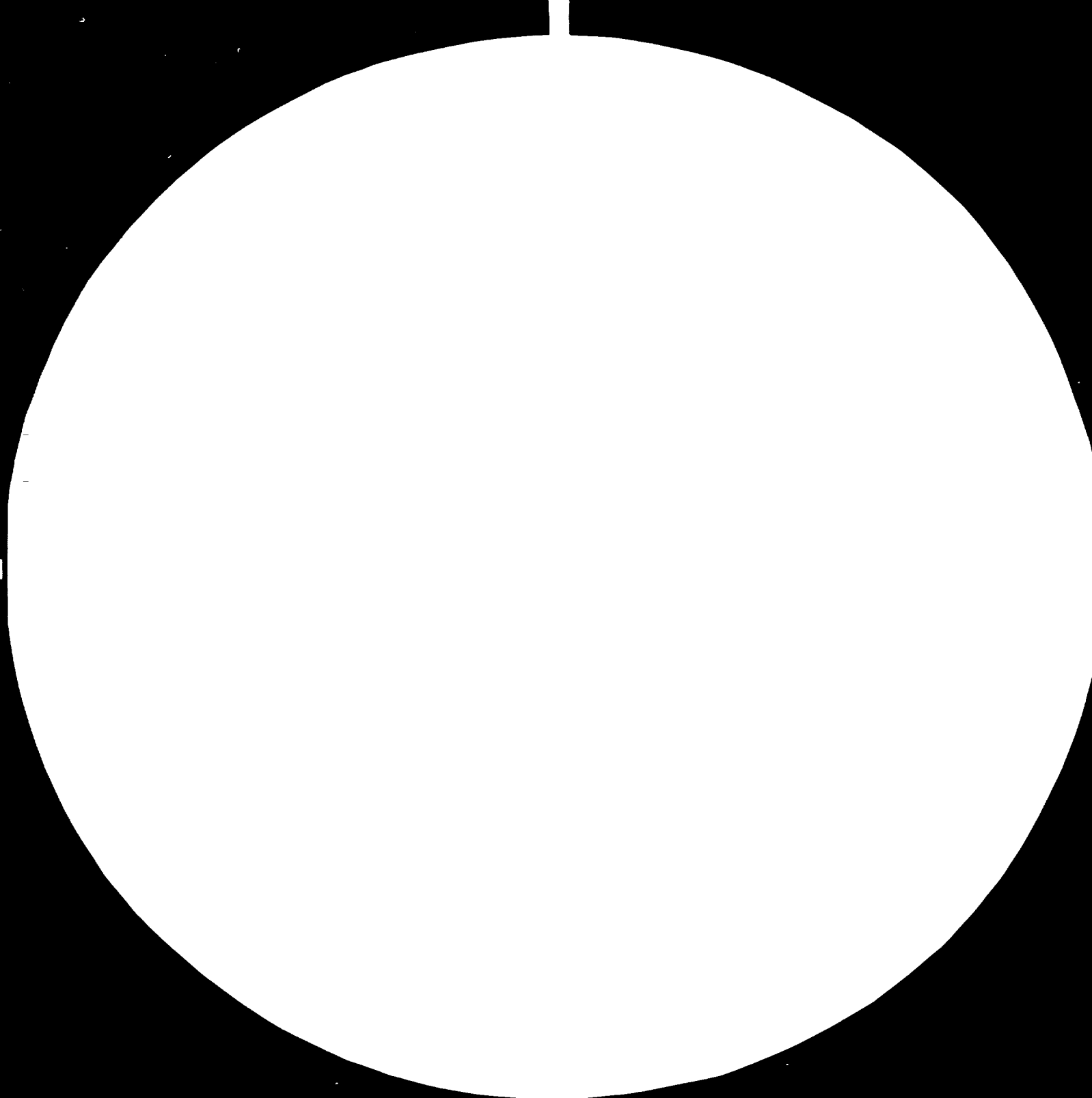

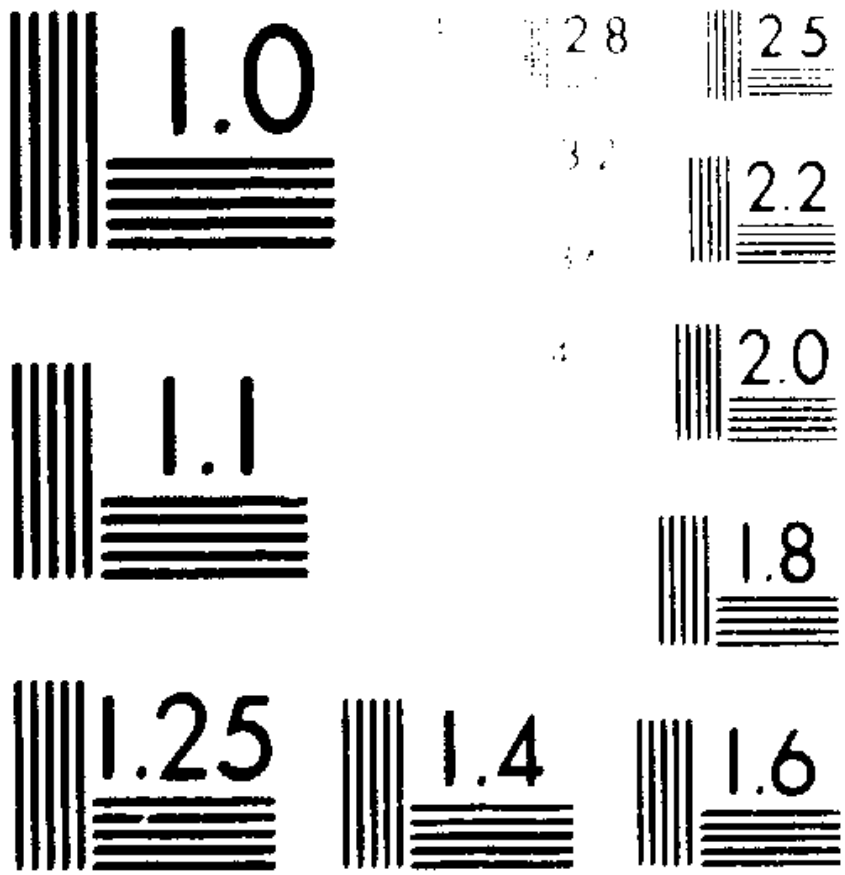
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CONSTRUCTION AND STARTING UP OF A PYRETHRUM REFINERY

DP/RWA/77/008

RWANDA

Technical report: Investigation of safety conditions at the pyrethrum refinery and reinspection of the solvent extraction plant at Ruhengeri*

Prepared for the Government of Rwanda
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

Based on the work of Stanley J. Klein, consulting engineer

United Nations Industrial Development Organization
Vienna

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I. SAFETY INSPECTION OF REFINERY

A. Summary

The pyrethrum refinery employs a batch process and utilizes material, all of which present the following hazards:

1. Danger of fire and explosion because of the combustibility and flammability of the pyrethrum feed material and process materials: Methanol and Kerosene and activated carbon.
2. Danger from toxicity of process materials.
3. Danger of loss of process control, i.e., overflow, over-heating and over-pressurization, resulting in possible rupture of vessel or spills of flammable fluids from operator error.
4. Danger of bodily injury from falls, impacts, burns, etc., under normal operating contitions and emergency situations.

As a result of the batch-type process, in accordance with the flow sheets of the plant, a continuous closed circuit is impossible to maintain. Consequently vessels must be periodically opened to atmosphere for charging of activated carbon, pumping out miscella of extract and methanol, emptied, cleaned and sampled. The methanol extract and kerosene filter presses and pressure filters must be opened for periodic emptying and cleaning. All of this causes a discharge of combustible, flammable and toxic vapors into the immediate plant environment. When the concentration of vapor reaches the explosive limit with air (see appendix 1), and a source of ignition is present in the form of a hot surface, open flame, static, electrical or percussion spark, then the possibility of a fire or explosion is present.

Moreover, when the dust or vapors of the process materials is introduced into the atmosphere there is also the danger of toxicity from inhalation, ingestion or external contact. Such manifestations may range in effect from mild to severe or fatal (see appendix 1 for particular data).

In addition, since the plant has been designed to be labor-intensive, the operator is depended upon to monitor the process parameters charge, discharge, sample and clean the vessels, increasing the possibilities of human error, with the obvious consequences previously mentioned.

It is, therefore, necessary to exercise greater than ordinary supervisory control, preliminary training, and provide continual reinforcement of instructions through posted signs and operators manuals.

B. PROCEDURE:

As a framework of reference for the safety evaluation of the refinery, the generally accepted standards of Safety Engineering practice were used. They are embodied in the following publications:

1. United States Department of Labor, Occupational Safety and Health Administration (OSHA). Safety and Health Standards - 22CFR 1910.
2. National Safety Council, Accident Prevention Manual for Industrial Operations.
3. National Fire Protection Association, National Fire Codes:
   a) Occupancy Standards and Process Hazards
   b) Portable and Manual Fire Control Equipment
   c) Combustible Solids, Dusts and Explosives
   d) Flammable Liquids
   e) Building Construction and Facilities

Such codes and standards are generally conceded to be minimal in stringency and constitute a concensus of U.S. Government agencies, Industry, Insurance Companies, Safety Institutes, Engineering Organizations, and numerous others concerned with the principles of Safety.

Consequently, in employing the principles of systems safety engineering practice, the following procedure was followed:

1. Identification of the hazards.
2. Evaluation of the risk of injury.
3. Elimination of the danger by:
   a) Designing the hazard out of the process.
   b) Guarding against inadvertent contact.
   c) Isolation of hazard.
   d) Warning of hazard.
   e) Cautioning against improper action.
   f) Instruction in proper procedure.

C. FINDINGS AND RECOMMENDATIONS:

In order to evaluate the safety of the refinery, an inspection was made of building, grounds, processing equipment, fire protection equipment, personal protective equipment, Safety instructions and safety organization. The following findings were made and recommendations follow:

1. Building, grounds and utilities:

   a) Outside escape ladders - the section running from first landing to ground should be isolated by a non-combustible, continuous wall, from the building. It is presently bisected by plastic windows and ventilating louvers, exposing it to probable flame. All landings should be equipped with toe boards. The bottom landing is intersected by the drainage trough, which should be covered by steel grating instead of plywood. At the top of the ladders the railings should connect to the ladder rails to close up the present unprotected gap.

   A second escape ladder should be located at the opposite end of the tower. The railings should be continued up to the ladder rails to eliminate the present gap.

   b) Entrances to building crossing over the perimeter drains should have railings on both sides of each walk way (Three required on side and one in rear.)

   c) The plywood covers to the perimeter drains should be removed or replaced by steel grating, to prevent possibility of breaking thru.

   d) Cooling towers - All power cables to overhead fans should be permanently attached and rigidly affixed to the structure. The end of underground conduit should be capped to exclude water and debris. The vent screen at rear and sides should be reattached to exclude debris. All pipes should be braced with steel brackets.

   e) All electrical power cables for equipment mounted at ground level should be completely protected by rigid steel conduit to eliminate the danger of impacts by mobile equipment and possible sparks from short circuit.

2. Walking-working surfaces:

   a) The stairway to the top of tank B-2 should be equipped with a right hand railing.

   b) The catwalks at the tops of tanks B1,B2,B5 & B6 should be equipped with toe boards and railings.

   c) Where access to the top of any elevated tank is required on a regular basis, cat walks with railings and toe boards should be provided or existing cat walks extended to make the work place safe.

   d) The catwalk to the tops of tanks B22,23 should be equipped with a railing and toeboards and extended as necessary to enclose the entire work area.

   e) Catwalk to top of tank B9 should be equipped with railings and toeboards and extended as necessary to provide safe access to the entire work area.

f) Catwalk between B13,14 should be provided with toe boards and extended as necessary to provide safe access to entire work area.

g) The short stairway serving the catwalk behind tank B16 has unsafe gaps behind each tread. The treads should be closed to prevent stepping through the openings.

h) The short stairway serving the catwalk behind B13,14 should be changed to consist of 2 treads instead of the present one. Add a hand rail to the right side.

i) Emergency lights should be provided in event of power outage - to be operated by automatically rechargable batteries with automatic emergency actuation.

3. Process hazards:

a) All sampling faucets for tanks containing methanol, kerosene, or mixtures of either, should be equipped with catch pans below, having drain cocks for emptying.

b) The sampling valve, adjacent to the ladder access to tank B2, should be protected against accidental impact and actuation.

c) All vessels under manually controlled, elevated temperature or pressure should be equipped with maximum level safety switches which will sound an alarm (both audible and visible) when the set temp/press is exceeded. In addition, there shall be posted signs warning of the danger of over temperature or pressure and instructing in the safe procedure for control and/or shut down.

d) All vessels under manually controlled level control should be equipped with maximum load safety switches which will sound an alarm (both audible and visible) when the set level is exceeded. In addition, there shall be posted signs warning of the consequences of exceeding the safe levels and instructing in the safe procedure for control and/or shutdown, to avoid a dangerous spill, or rupture.

e) All pipes should be rigidly secured against movement by suitable brackets and braces permanently installed, including continuous runs as well as those adjacent to couplings, which when disassembled, will cause the pipe to be freely suspended and subject to breakage or strain.

4. Accident Prevention and Control:

a) All warning signs on the outside walls should be constructed of aluminum instead of plastic film and have weather-proof lettering.

b) All exits should be marked with illuminated red signs indicating "exit" with arrows directing pedestrian traffic to the nearest exit on each floor.

c) The cabinet containing emergency Safety equipment such as gas masks, respirators, safety belts and life-lines should be accompanied by instructions on use, with a copy stored in a pocket of the cabinet.

d) A tether rope and safety belt are to be provided for entering all vessels for any reason.

e) General safety instructions for operation and maintenance are to be posted at each end of the refinery in two languages.

f) All nameplates and processing instructions are to be provided in French and Kenya-Rwanda.

5. Fire Preventation and Control:

a) The electrical cable connecting the structure to ground, located in the left front corner of the building is not sufficiently tight and could disconnect. The cable coupling should be securely crimped. Where it crosses the outside perimeter drain, it should be protected by a permanently fastened steel conduit.

b) Fire hoses should be provided for outside connections to the water line and stored in an accessible shed along with other fire fighting tools. At present there are no outside hose lines for the refinery.

c) A CO_2 portable fire extinguisher should be provided for the electrical power control room and hung on the wall adjacent to the exit.

d) Electrical bonds should be provided for all couplings which interrupt a continuous run of pipe having combustible or flammable fluids, in which the material is not corrosion-resistant.

e) Floor drains or impoundment curbs should be provided to retain spills or inadvertent discharge of flammable solvents from all tanks discharging to atmosphere, where such flow would empty on to the ground.

f) 11 portable fire extinguishers are to be wall-mounted on suitable brackets.

g) Every tank or vessel containing flammable or combustible fluid is to be connected by a suitable ground wire to the steel building structure.

h) Interior fire hoses are to remain permanently connected to the water line and supported on a suitable bracket. Such hose lines shall reach to the opposite end of the building.

i) Neutral atomosphere of CO_2 or N_2 is to be introduced to all tanks or vessels containing flammable fluids, prior to removing a port to atmosphere for charging or discharging. Such procedure will prevent the formation of an explosive mixture of air.

j) Forced ventilation is to be provided for the hydraulic filter presses by means of exhaust shrouds at each side ducted to the nearby exhaust fans. Flow rate shall be sufficient to prevent reaching the lower explosive limit and emission of toxic vapors above the allowable limit of toxicity.

k) Additional exhaust ventilation is to be provided along the hall perimeter in the proximity of all flammable solvent vessels to remove vapors in the event of spill, below the L.E.L.

l) Provide an independant foam generator for use with the water line and to be used in combatting kerosene fires.

m) Provide a means for recharging all fire extinguishers.

D. CONCLUSIONS:

From a purely functional standpoint, the refinery can operate, but not without a calculated risk:

1. From fire and explosion.
2. From toxicity of process materials.
3. From injury due to falls and impacts to head.

In the absence of automatic controls to prevent over-filling, over-pressurization and over-heating of process vessels, it will be necessary to offset the total dependance on humans by exercising the following measurers:

1. Organize a safety committee to conduct frequent periodic inspections and monitor all safety implementation and personnel training.
2. Employ abundant instructions, warnings and cautions, posted in the work place and in operators manuals, written in both Kenya Rwanda and French.
3. Train, as soon as possible, counterparts to fill the positions of Technical Director, both mechanical and chemical.
4. Provide for the project a set of the latest Safety Codes and Regulations referenced herein.

II. RE-EVALUATION OF SOLVENT EXTRACTION PLANT

A. Introduction

At the request of UNIDO office the original mission was expanded to include a re-evaluation of the solvent extraction plant. This follows previous efforts outlined in the reports below:

Technical Report No. 1: Investigation of Safety Conditions at USINEX Pyrethrum Extracttion Plant, Ruhengeri, Rwanda, March 1, 1974 (DP/RWA/66/503/11-10/A/05)

Technical Report No. 2: Implementation of S fety Programme at USINEX Pyrethrum Extraction Plant, Ruhengeri, Rwanda, January 31, 1977.

B. Re-evaluation of Extraction Plant

(Excerpt from Tech. Report No. 1 March 1974, para. "C" Findings and Recommendations).

1. The Pyrethrum Preparation Block No. 5

Inspection of this block revealed the following deviations. Recommendations for necesssary modifications are accordingly given.

PURCHASE DEFERED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING
			✓
			✓
			✓

(a) Cleaning and Milling Rooms: Intake hopper and frame of cleaning machine are made of wood, and constitute a fire hazard in the event of ignition. Should be lined with sheet aluminium. The hopper should be replaced with aluminium, adding a round funnel top for convenience in unloading the sacks.

(b) Dust escapes from cleaner, mill and bag filler. Exhaust pressure should be increased by sealing clean-out doors, or increasing motor speed. Dust collector filter bags should be placed out of the main building to lessen dust generation or isolated by partitions.

(c) None of the air ducted equipment is provided with explosion vents, is grounded and is best driven, constituting a hazard from statec spark ignition of the inherent dust. All the rubber belt drives should be changed to oil-immersed silent chain drives. The equipment should be vented to relieve explosion pressures and should be grounded.

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	
✓				(d) Neither of the dust collection systems is provided with an automatic sprinkler system within the enclosure. Installation of an appropriate system will offset the hazard of ignition from within.
			✓	(e) No enclosed, dust-tight, non combustible stair tower is available for egress from both ground and second floor. Such isolated exit is manditory in the event of fire.
	✓	✓	✓	(f) Insufficient number and type of portable fire extinguishers are available in this building. It is recommended that the mill be equipped with (one foam and one CO_2) portable extinguisher on each floor. The two extinguishers and fire buckets in the mill storage room should be mounted to the wall in appropriate manner. For the raw material warehouse area it is recommended that four foam extinguishers be wall mounted and spaced around perimeter of room. Access to all extinguishers should be free and unblocked by storage materials.
X				(g) No self-closing fire doors opening in the direction of egress on each floor for each work area. Installation of such doors would contain local fires.
			✓	(h) Openings in outer wall of building not covered by wire screens. Such installation serves as flame arrestor, preventing intrusion of sparks from outside in the event of fire.
				(i) Shovels and other tools are not spark resistent. Use of bronze edges on shovels recommended.
			✓	(j) Floor not spark resistant, should be aluminium covered.
			✓	(k) More prominent "NO SMOKING" signs at each entrance and within each area.
			✓	(l) empty sacks and other combustible material to be stored outside the cleaning room.
			✓	(m) Accumulated dust should be vacummed from floors and all other surfaces daily, discharging into main stream.

✓ = Problem Exists
X = Problem Reassessed

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	
			✓	(n) The one watchman station in the raw material warehouse should be expanded to two or three and located at the building extremities.
			✓	(o) Present method of stocking sacks provides no aisle at the outer walls and insufficient aisles within the stocking area, creating large inaccessible areas which could burn uncontrolled in the event of a fire. It is recommended that parallel aisles be marked and maintain at approximately 20 feet intervals for the length of the building, intersecting the perimeter aisle. All aisles to be 6 feet wide and stacks to be piled pyramidally.
			X	(p) The building should be equipped with explosion vents in both stores of the mill area at the rate of 1 $ft^2/50\ ft^3$ volume.
			✓	(q) Opening around loading hopper of cleaning machine large enough to accept operator's foot; should be covered with floor plate.
			✓	(r) Not all mill operators wear masks. To prevent respiratory irritation all operators must wear masks (of a better construction than existing).
			X	(s) Interior stairing to 2nd. floor of mill partly blocked by bags; must be kept clear at all times.
			✓	(t) Existing "explosion proof" electrical cables can be easily perforated and cut, igniting possible dusts and debris on floor. Electrical cables should be mechanically protected where exposed to injury.

✓ = Problem Exists
X = Problem Reassessed

2. The Extraction Block No. 6

Inspection of this block revealed the following deviations. Recommendations for necessary modifications are accordingly given.

PURCHASE DEFERED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLATION PENDING	
✓				(a) No purging system used for inerting the extraction vessels prior to residue discharge or cleaning, repair. This presents a very serious fire hazard at the completion of each cycle. With incomplete steaming of the grist, flammable vapours are emitted from the discharge door, filling the building. As the vapour concentration reaches the lower explosive limit, ignition becomes imminent from static or impact sparks. Purging gas such as CO_2 or N_2 should be introduced directly after steaming to displace the air as the residue is moved. At the time of discharge, the grist is at 80°C and 0.1 - 0.4 Kg/cm^2. The vessel is not always completely vented due to blocked condenser filters. Operator carelesness in not checking pressure gauge or testing odor at vent valve can cause the solvent vapour to issue forcefully from discharge door, increasing the fire hazard. Only one recording chart is available for monitoring vapour temperature of all 6 extractors. It is recommended that exhaust air ventilation be installed with hoods above each discharge door to dissipate solvent vapours present, exhausting to outdoors. Additional recording gauges would insure closer control of solvent temperature. More suitable condensor filter media would prevent undesirable blocking and assure complete venting of the extractor vapour.
✓				(b) No system of fire protection other than portable extinguishers exists within the building. It is recommended that a water sprinkler deluge system be installed above each vessel containing hexane. This system would be supplied from an independent water tank of sufficient capacity to insure at least 30 minutes duration. An alternate system could be wall-mounted hose reels within the building at suitable intervals for accessability to equipment. The present outside hydrant connections do not provide adequate inside protection. The system should be extended to provide inside hydrant connections.

PURCHASED DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	
	✓		✓	(c) The existing one explosimeter is in need of repair. Consequently no means are available for monitoring ambient vapour concentrations, thereby providing early detection of flammable and explosive conditions. The explosimeter is an indispensable instrument which must be used continually. It is recommended that two such instruments be kept in working order.
			X	(d) The use of rain water drainagetrenches around the outside perimeter is dangerous providing an accumulator for flammable solvent vapours. Such channels are prohibited within 100 feet of the extraction process.
✓				(e) The outside two-storey stairway is not totally enclosed, with non-combustible material and accessible by three self-closing fire doors at each landing.
			✓	(f) Grist discharge chute is made of combustible material. Should be of non-combustible, non-sparking material such as aluminium.
			✓	(g) Concrete, lower floor grist discharge platforms conducive to impact sparks. Should be aluminium covered as well as other floor plates.
✓				(h) No alarm system to warn of abnormal or hazardous process conditions such as: loss of steam, loss of condenser water pressure, failure of process pumps or ventilation system fans; fire alarms, stopped motors, etc. Installation of such provides assurance of safe operation, preventing conditions leading to process interruption, vapour accumulation and subsequent fire and explosion.
✓				(i) Safety interlocks are recommended to provide for safe shutdown in the event of a vital process interruption.
✓				(j) Manual charging of extractors create a dust problem which can be eliminated by means of an exhaust hood over the charging door.

✓ = Problem exists

X = Problem Reassessed

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	
			√	(k) Electric cables to motorized equipment, wall switches and other controls are exposed to mechanical damage by pedestrian traffic. Such cables are explosion-proof only when free from cuts, punctures and other damage, at which time ignition of flammable vapours is possible. All exposed sections of cables should be protected in rigid grounded pipe.
				(l) Many steel tools are being used in lieu of bronze types. This creates iminent hazard of vapour ignition if dropped. All steel tools should be replaced with non-sparking type.
			√	(m) The floor below the extract storage tanks should be diked with a total capacity to contain the contents of both tanks in the event of leakage.
			√	(n) Removable valve levers at middle level can disessemble and fall to floor injuring persons below. Should be cross pinned or chained to secure.
			√	(o) Water drain valves below extractor vessels, if opened accidentally during extraction cycle, can empty complete solvent content of vessel into drain system into separator. Much solvent vapour would escape to room. These valve levers should be locked by foreman and only opened on occasions for draining water. Electrical interlocks could also be employed, locking the valves during solventizing.
			√	(p) Flange plates of solvent lines not all electrically bonded. Some bonding straps loose, other missing.
			0	(q) Dike surrounding entrance to underground cable duct to electrical control room is broken, providing possible flow of hexane vapour or fluid to control room and resultant ignition by electric spark. In such case, flame would propagate back to extractor building. Duct should be filled in or blocked each end with vapour tight bulkhead.

√ = Problem Exists
X = Problem Reassessed
0 = Problem Corrected

			✓	(r) The present ventilation exhaust system is inadequate. The intake grills are half plugged with dust and are located too high above the floor. It is recommended that the intake grills be located within two inches of the floor. That sufficient air flow be provided to keep below the lower explosive limit of hexane vapours (1,290). Most ventilation is required in the extractor area. It is further recommended that the exhaust grills be cleaned once a day or sufficiently often to prevent reduction of the effective area by dust residue. It is recommended that the exhaust grills be redesigned to provide continuous perimeter air discharge. Air exchange within the building should be no loss than 6 complete air exchanges per hour.

3. Solvent Storage System

Inspection of the solvent storage system reveals the following deviations. Recommendations are given directly after each item:

			0	(a) Electric cable to solvent transfer pump motor unprotected from mechanical damage. Sparks can readily ignite solvent vapour from transfer operation (from shipping drums to storage tanks). Cable should be armoured in pipe.
			✓	(b) Flanged pipe connection not all electrically bonded. Some bonding straps are loose. Positive connections are necessary to safely bleed static electricity to ground.
			✓	(c) Solvent pipelines to tank inadequately braced against lateral deflection. Must be supported to prevent possible puncture of pipe and connections.
			✓	(d) Concrete block tank pit is filled with ground water; conducive to corrosion of tank; which is relatively unprotected. Should be properly cleaned and coated with asphalt or other rust-proof paint. Tank pit should be filled in to avoid vapour accumulation.
PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	

✓ = Problem Exists

0 = Problem Corrected

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLATION PENDING	
			✓	(e) Pipe duct from solvent tank to Block 6 is exposed to solvent vapour in event of leak or spill. Should be filled in.
			0	(f) Solvent transfer hoses deteriorated. Can cause leakage on to ground. After transfer solvent retained in pump free to flow on to ground hose. Should be replaced with suitable type and pump properly drained after using.
			0	(g) Hexane storage area in open yard behind block 6 should be diked or graded away from all buildings in the event of a leak. Drums not adequately marked with warning label. A fire control device should be located nearby, preferably hose side, and foam extinguishers (kept under cover). A shed should be provided to protect drums from heat of sun. Max. No. gallons/pile = 2200, Distance between piles = 5 ft. min.

4. Electrical Control Room

			✓	(a) Underground cable duct to Extractor Block 6 constitutes a hazard from fire and explosion. A solvent spill in Block 6 would transmit vapour to the Control Room due to broken dike in Block 6 which would be ignited by electrical spark in Control Room. This duct should be filled in or blocked by vapour tight bullhead at each end.
			0	(b) Provide a CO_2 portable extinguisher for this area.

5. Machine Shop

			✓	(a) Flexible rubber electric cables to various machines are laid on floor and are exposed to mechanical damage. Should be protected at floor level by grounded steel armor.
			✓	(b) Safety goggles should be mandatory throughout machine shop to protect against flying particles.

✓ = Problem Exists

0 = Problem Corrected

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING	
			0	(c) All arc welding should be done behind shitable screen to protect other workers from injurious arc flash.
			✓	(d) Shoes should be worn in the machine shop at all time to protect against cuts from steel chips and crushing injuries from dropped heavy objects.

6. Boiler Room, Fuel Oil Storage and Water treatment Tank

			✓	(a) Sight gauges for boiler feed water are inoperative. Should be replaced with approved types.
			✓	(b) Exposed electrical connections to pump should be enclosed in approved coupling box.
			✓	(c) Lable should be affixed to boiler showing manufacturers rating: Boiler horsepower, steam output and rated pressure and temperature and tagged with latest test certification.
			✓	(d) Oil storage tank should be diked with a capacity for the full tank. Should be located 25 feet minimum to boiler room or other buildings. Leakage would fill present rain drainage trench and encircle boiler room with combustible liquid.
✓				(e) No fire extinguishing system is provided for the fuel tank. An approved portable foam tower is recommended in addition to a water hydrant connection nearby.
				(f) Drain valve handle should be removed to prevent accidental opening.
				(g) Treatment water tank should be equipped with an enclosed safety ladder.

✓ = Problem Exists
0 = Problem Corrected

7. Fire Protection System

Because of its importance the following points are summarized under this caption even though some of them may be covered previously under separate headings:

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLATION PENDING	
✓				(a) The present water hydrant system should be expanded to provide hydrants at each corner of Block 6, with standpipes feeding wall-mounted hose reels within the building.
			✓	(b) Outside hose lines should be stored readily accessible in suitable sheds at centrally located hydrants. They are presently stored remotely from hydrants.
	✓			(c) All hose noggles should be combination of fog and stream types.
✓				(d) An automatic water deluge spray system should be installed above the extractor and other solvent vessels.
			✓	(e) Additional portable extinguishers should be provided in accordance with the original report of 1974. Many existing units are stored on the floor or are blocked by stored materials, etc. All portable units should be wall-mounted in approved manner. They should be inspected and tagged periodically in accordance with approved procedure. An inventory must be maintained with locations designated.
✓				(f) Independent water supply tank should be installed for fire protection system to provide water for at least 30 minutes duration. Present supply is from a limited capacity tank on hillside primarily for process.
✓				(g) A standby pump should be available at the pump house which can be available in the event of break-down.

✓ = Problem Exists

			✓
	✓		
			✓
	✓		
			✓
			✓
	✓		

(h) Present diesel-driven pumper should be kept in shed for protection against the elements. Pumper chassis wheels should be blocked against movement to prevent straining hose and connections. Chassis should be realigned with hose connections.

(i) The existing canvas hose not suitable for foam. Should be replaced by suitable type.

(j) After each using the canvas hose should be drained and dried before using.

(k) Hose attachment to standard coupling should be secured against leakage with approved clamps.

(l) Foaming agent is supplied from a limited number of five gallon containers through an aspirator on the pump. Containers are kept in the open subject to corrosion and leakage. Should be stored under cover and preferably should be replaced with one large tank.

(m) The fire system main supply valve should be sealed in the open position (closed only for repair) and monitored by periodic inspection.

(n) A combustible gas detection system is recommended for Block 6, with detectors suitably located and connected to an alarm system, both visual and audible. (Portable detector ordered).

8. Garage

			0
			0

(a) A fire hydrant is located directly over a work bench adjacent to a pipe vise. It is recommended that the bench be moved to provide free access to the hose connection.

(b) A CO_2 portable extinguisher should be provided in accordance with the original report of 1974. (Garage Relocated).

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLATION PENDING

9. General Safety Practices

PURCHASE DEFERRED	DELIVERY PENDING	UNACCOUNTED FOR	INSTALLAT'N PENDING
			0

(a) A safety Department should be organized and charged with the responsibility for setting safety policies and operating procedures recommending necessary life and fire protection equipment, modifications to present process and facilities, conducting fire drills, use of safety equipment, clothing and plant security and all other matters affecting the health and safety of plant personnel.

√ = Problem Exists

0 = Problem Corrected

C. Summary

In general, most of the recommendations made by this expert in the report of March 1974 have not been accomplished. This is due to the following reasons:

1. Decision by UNDP to defer purchase of certain recommended, high-cost equipment.

2. Equipment has been ordered but lost in transit, or mislaid in storage.

3. No time has been allocated for installation by local personnel.

4. Equipment or materials ordered but delivery pending from the vendor.

With reference to Chapter II/B above the status of the safety programme in the Extraction Plant is indicated by a (√) preceding the paragraphs of "Section C. Findings and Recommendations", (excerpt from Report No. 1 of March 1974).

In addition to the above, some equipment has fallen into disrepair creating further hazard to process and personnel, mainly:

1. Electrical bonding has been removed from hexane lines during repairs and not replaced.

2. Electrical ground wire has been lost from the outside hexane charging system.

3. The storage battery has been removed from the engine-operated fire pump, located in the open storage shed. The battery cables are broken, the only battery charger is awaiting repair. The shed is congested with bicycles being stored. The fire hose is worn and draped loosely on the ground. The foam additive aspirating pump is not stored near the fire pump. What little fire hose now existing is stored remotely from the hazard areas.

4. The fire shed (for storing hose, nozzles and other fire fighting tools) has been dismanteled.

5. Many existing fire extinguishers have been used and never recharged - some left hanging but empty. Many have been labeled as having been inspected on April 18, 1981, but strong evidence indicates that they have never been removed from the wall, or otherwise touched in months. The recharging system ordered a year ago has disappeared.

6. The safety committee happily, if ineffectively, continues to make Wednesday morning inspections of the premises, using a well organized check list (see Appendix 2.) However, many of the items checked off each week remain undone since 1977 when first organized, including fire drills (see Appendix 2.

Another continuing problem is improper identification and storage of incoming machinery and equipment used for routine maintenance and new equipment awaiting istallation. Such lack of organization promotes loss, facilitates theft and prevents proper protection of the equipment. As a result, some of thesafety equipment previously purchased as part of the 1977 safety implementation programme is already unaccounted for or misallocated to the wrong departments (see list in Appendix 3).

D. Recommendations

The serious lack of concern for safety starts at the top. It is evident by the lack of positive accomplishment and concern for most of the recommendations made in 1974.

The entire programme must be undertaken systematically, as with any project. Each item or task must be scheduled with the necessary manpower and materials allocated, then assigned and followed up to completion. The necessary direction and overall management must come from the Technical Director, with lower level supervision from the shop foreman and coordinated with the Safety Manager.

With UNIDO Experts Gelmini and Tetard acting, now, only in an advisory capacity to OPYRWA, it is abundantly clear that their important recommendations are not being followed, as appears from correspondence on the subject between the UNIDO project and OPYRWA.

There can be only one result. It will only be a question of time before the extraction plant comes to a sudden halt (either from fire/explosion or mechanical breakdown).

Since accidents are statistically random occurences, just when a casualty or catastrophy, or equipment breakdown will occur, is indeterminate.

III. APPENDICES

Appendix 1: Dangerous Properties of Process Materials

Properties - Flammability	Methanol	Kerosene	Refined extract of Pyrethum
Lower explosive limit (% by Volume)	5.5	0.6	-
Upper explosive limit (% by Volume)	36.5	5.6	-
Specific gravity, liquid (water =1.0	0.792	0.81	0.845-0.865
Vapor density (air = 1.0)	1.11	4.5	-
Flash Point (^{o}C)	11(c.c)	54 (c.c.)	82 (toc)
Auto ignition temperature (^{o}C)	455	405	-
Properties - Toxicity			
Inhalation allowable limits (MAK) (mg/cu M air)	(200 ppm) 200	2560 ppm 2000	-
Long term inhalation effects, leading to vision defects (mg/cu.M)	< 1000	-	-
Ingestion, resulting blindness (gm)	8-10	-	-
Ingestion, resulting death (gm)	10-100	=	-
Absorption (gr/Kg of body weight)			1-2

USINEX VISITE SECURITE DU		B1	B1	B2	B2	B2		B3	B3	B3	B4			B5	B5	B5	B5	B6	B6	
REPERE	DESCRIPTION	LABORATOIRE	STOCK EXTRAIT	BUREAUX	MAGASIN	Pt. GENERATEUR	GRAND GENERATEUR	GARAGE	ATELIER	MAGASIN	CHAUDIERE	MOTO-POMPE	EQUIPEMENT INCENDIE	SALLE COMMANDE	STOCKAGE FLEURS	BROYAGE	STOCKAGE FARINE	EXTRACTION	REMPLISSAGE	NUMERO DE BON DE TRAVAIL
1.	ETAT GENERAL DES LIEUX a) Outils rangés proprement. b) Sols propres et secs c) Murs et autres surfaces propres d) Cour propre																			
2.	MATERIEL DE TRANSPORT ET DE STOCKAGE a) Sacs empilés proprement b) Allées accessibles c) Appareils de lavage en bon état et stockés proprement																			
3.	AIRES DE PASSAGE ET DE TRAVAIL a) Surfaces séches et propres b) Balustrades, plinthes de sécurité c) Aires convenablement éclairées																			
4.	EQUIPEMENT INCENDIE a) Extincteurs inspectés et stockés convenablement b) Seaux de sable plein et accessibles c) Bouches à eau accessibles d) Mises à la terre et ponts électriques e) Moto-pompe inspectés et stockée convenablement f) Tuyaux flexibles stockés convenablement g) Générateur de mousse stocké convenablement h) Carburant pour moto-pompe stocké convenablement																			

Rep.	DESCRIPTION	LABORATOIRE B1	STOCK EXTRAIT B1	BUREAUX B2	MAGASIN B2	Pt. GENERATEUR GRAND GENERATEUR B2	GARAGE B3	ATELIER B3	MAGASIN B3	CHAUDIERE MOTO-POMPE B4	EQUIPEMENT INCENDIE	SALLE COMMANDE B5	STOCKAGE FLEURS BROYAGE B5	STOCKAGE FARINE B5	EXTRACTION B6	REMPLISSAGE B6	Numéro BON DE TRAVAUX
5.	RESEAU DE VENTILATION a) Collecteurs de poussière vides b) Grilles d'aspiration propres c) Commutateur ON-Fonctionne																
6.	MACHINES ET INSTALLATIONS a) Carters de protection des parties tournantes b) Masques de soudeur en bon état c) Manomètre propres et accessibles d) Instruments de contrôle accessibles																
7.	SECURITE GENERALE a) Equipement de premier secours accessibles b) Equipement de sauvetage accessibles c) Détecteur de gaz accessibles d) Lunette protectrice en bon état e) Respirateurs en bon état f) Avis de sécurité placardés																

REP.	TRAVAUX EN COURS N° B.T.	OBSERVATIONS	INSPECTEUR
			Visa :
			Directeur du Projet
			Visa :
			Directeur de l'USINEX
			Visa :
			Remarques 0 : NON SATISFAISANT 1 : SATISFAISANT

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March 21, 1977

Appendix 3: List of Safety Equipment ordered for the Extraction Plant

Mr. M. Mant
UNIDO
P. O. Box 707, A-1011
Vienna, Austria

Re: DP/RWA/66/503/11-10/A/05

Dear Mr. Mant,

In accordance with debriefing instructions from Mr. Gabre-Madhin at UNDP, Kigali, Rwanda, I have enclosed quotations from U. S. suppliers for equipment reccmmended in my final report of January 31, 1977.

The attachments provide additional data where necessary. The accompanying prices are from the U.S. sources indicated. It is expected that comparable items are available from European sources at savings.

Please feel free to call on me if I may be of further assistance.

Very truly yours,

Stanley J. Klein, P.E.,C.S.P.
Expert on Mission

SJK/ek

Encl. Price list
Attachments

cc. Mr. M. C. Verghese
Mr. Gabre-Madhin

Qty.	Description	Supplier	Price	Amount
1	Fence Guard Electronic perimeter intrusion alarm system	ACD Alarms 34 Victoria Dr. Rochester, NY 14618		
	205 Sensor units at $13.75 ea. (1 unit per 10 ft. perimeter)		2818.75	
	1 Control panel		295.00	
	1 Remote station		37.50	
	1 Bell		50.00	
	1 Coil wire 2045 ft. at .10		204.50	
	1 Set Spare parts:			
	2 Sensors at $13.75		27.50	
	1 Master control		295.00	
	1 Remote Station		37.50	
	1 Bell		50.00	
				3815.75
2	Kidde 150 lb. Mobile, dry chemical fire extinguisher	Rochester Fire Equip. 83 Howell St. Rochester, NY 14607	1562.50	3125.00
2	Kidde, 50 lb. Mobile CO_2 fire extinguisher	"	812.00	1624.00
1	Kidde, manual foam system	"	1200.00	1200.00
8	Chemetron 6 lb. dry chemical portable fire extinguisher	"	30.00	240.00
4	50 lb. drum dry chemical fire extinguisher powder	"	25.40	101.60
1	Recharging kit	Rochester Welding Supply 510 State St Rochester, NY 14608		
	1-Cylinder for nitrogen gas 224 ft.^{3} (2200 psi) with shut off control		105.00	
	1-Nitrogen gas refill 224 ft.^{3}		9.41	
	1-Regulator		85.00	
	6 ft. Pressure hose		10.00	
	1 set Fittings		10.00	
				219.41

Qty.	Description	Supplier	Price	Amount
1	Fire detector alarm system for flower warehouse for use with Intrusion Control	ACD Alarms		
	4 Rate of rise heat detectors at $15.00		60.00	
	1 Tester		30.00	
	1 12V Battery		10.00	
	1 1500 ft. wire at .10/ft.		150.00	
	1 Remote station		37.50	
				287.50
1	Combination hose nozzle for spray, fog, stream	(See existing British source for 2½" British standard)		
1	Portable explosion meter for hexane and calibration test kit	Mine Safety Appliance 519 Niagara St. Tonawanda, NY 14150		
	1 MSA explosimeter Mod. 2A, Cat. 89220		160.00	
	1 Sampling line 11354		5.75	
	1 Probe tube 11961		9,25	
	6 Dry cells 30052 at .44/ea.		2.64	
	1 Calibration test kit 454380		14.85	
	1 Can Calibration gas 96329		11.75	
				204.24
1	Fire fighting tools, Craftsman 32 ft. extension ladder	Sears, Roebuck 275 Monroe Ave. Rochester, NY 14607	154.99	
1	Elkhart 627 axe	Rochester Fire Equip.	42.50	
1	Teledyne portable lamp	"	49.95	
1	Elkhart 630 crowbar	"	27.05	
1	Craftsman 48" shovel	Sears, Roebuck Co.	6.99	
1	Craftsman 16" adjustable end wrench	"	15.97	
1	Norton 724 First Aid Kit	Rochester Fire Equip.	39.95	
				337.40
3	Norton 2849 Safety glasses	"	5.60	16.80
12	Norton 7501 Respirator masks	"	15.95	191.40
100	Refill filters Norton 7500-68	"	3.60	360.00
6	Dust goggles Norton 1012	"	3.85	23.10
1	Singer 12-023466 Welding screen	"	108.00	108.00
3	Norton 6548 Face shields	"	7.80	23.40
	Osborne non-sparking tools reqd.	"	-	-

Qty.	Description	Supplier	Price	Amount
2	Justrite 10921, 5 gal. approved solvent container	Rochester Fire Equip.	44.40	88.80
1	Manostat Utility pump 15W 1740 plus hand crank 15W 1741	Ward's Natural Science 3000 E. Ridge Rd. Rochester, NY 14622	94.00	94.00
1	20 ft. length Retainer chain for valve levers (Brass jack chain) at .20/ft	(any mill supply house)		4.00
8	Teledyne 2M6N20 Big Beam emergency lights with Ni-Cad battery and PT power pack 220/115v.	Rochester Fire Equip.	310.00	2480.00
8	Pr. Vapour tight fixtures Mod. VTF6 - 16	"	30.00	480.00
8	Spare bulbs 4013	"	4.00	32.00
				$15,056.40