CHAPTER 12

WORK PLANNING

INTRODUCTION

There are two elements to getting any job done at Point Lepreau G.S.: **planning it** and **doing it.** These elements go together. To make things happen correctly requires a lot of teamwork from all work groups in the station.

The emphasis in this chapter is on **planning.** It is important that jobs are carefully planned so that they are done efficiently and safely. Not only from the point of view of radiation safety and dose minimisation (ALARA); you must also consider industrial safety, and that is a whole can of worms by itself.

One or more people will usually do planning of complicated or unusual projects. On the other hand, many routine maintenance or operating jobs are planned by the person who is going to do the work.

HOW WE CONTROL WORK AT PLGS

Almost all of the jobs that need to be done at the station have to run the gauntlet of a rather formal control process. Generally, this involves the following procedure:

Work that needs to be done is identified on a **Work Order Report of Deficiencies (WORD)**. This is a form that can be raised by anyone on the Station, e.g., an operator finding a leaking valve. The WORD is submitted to his supervisor for review, and then sent to the Planning Group.

Planning enters the WORD in their computerised scheduling system, and then sends it to the responsible work group to assess the job in terms of materials, manpower, prerequisites, hazards, and whether work groups other than their own need to be involved. If other work groups are to be involved, the person assessing the job should raise separate WORDS to those work groups. The need for a Work Plan is identified at this time. Depending on the complexity of the work, the System Engineer will be involved during the assessment/work planning process.

Work at Point Lepreau is completed using two processes, a formal eight-week forward scheduling process and a Fix-it-Now (FIN) team.

- Using the forward scheduling process, eight weeks before the schedule implementation (T-8), a list of work is developed. During the time from T-8 to three weeks before implementation (T-3), the work is assessed, parts are confirmed available, and the schedule is reviewed by Operations. At T-3, the schedule is frozen with agreement of all parties and the schedule is ready for implementation. Work Permits for this work are requested a minimum of three days before the work is to be done. This is to allow time for Operations to prepare the appropriate work protection and assess the impact of the work on the present plant state. If a **Safety Work Plan** is required (more on the SWP later), the Shift Supervisor and Health Physics must approve it before the Work Permit and SWP package can be issued. When the job is ready to begin, the Work Permit (and the SWP if applicable) is issued by Operations to a member of the work group doing the work. The work may now proceed.

- The FIN Team is made up of the shift Mechanical and EI&C resources. The Shift Supervisor reviews WORDS: if he identifies them as being of a short duration and if there are no barriers or restraints from doing the work now, the work is completed. Such work is normally assessed and completed within the shift to which it is assigned.

After the work is completed, the Work Permit is surrendered to Operations. The work group completes the "Work Done" section of the WORD and returns it to Planning. The work group may also prepare and attach a **Work Report** to provide additional information on complex jobs.

JOB SAFETY ANALYSIS

Job Safety Analysis (JSA) is a technique for uncovering the potential hazards that you may meet when doing work. It should be used for all jobs, large or small. It is particularly useful when jobs are to be done with minimal supervision. Careful attention to JSA and work planning will help ensure that jobs are done safely and with minimum radiation dose. The basic steps are:

1. Define the job.	**3. Identify the hazards.**
2. Break the job down into steps.	**4. Apply the necessary controls.**

You must know exactly what you need to do (i.e., define the job), before you start. Breaking the job down into simple steps (what is to be done, not how it is to be done) will make it easier to identify the obvious requirements such as materials, tools, manpower, information required, and hazards. In addition, it will bring out those things that are often forgotten, e.g., proper sequence of steps, cross-links with other systems, and unidentified hazards. When you've identified all the hazards, you must take the necessary steps to eliminate or control them.

THE WORK PROCESS INTERFACES

Any job that has to be done is affected by four basic elements, namely:

1. People.	**3. Equipment.**
2. Procedures.	**4. Environment.**

In addition to these elements, you must consider the interfaces between them. That is, the equipment to be used for the job must match the people doing the work, and the procedures must fit the people and the equipment. You would not ask a deaf-mute to run the switchboard (an example of an equipment-people mismatch), nor would you ask a paraplegic to climb a ladder (procedure-people mismatch). These are extreme cases to make the point, but I'm sure you get the drift. Fig. 12.1 shows these elements and their interfaces in the form of a wheel.

We call it a Safety Wheel, because if you match the people, the equipment, the procedures and the job environment to one another, you will have done much to ensure that the job can be done safely.

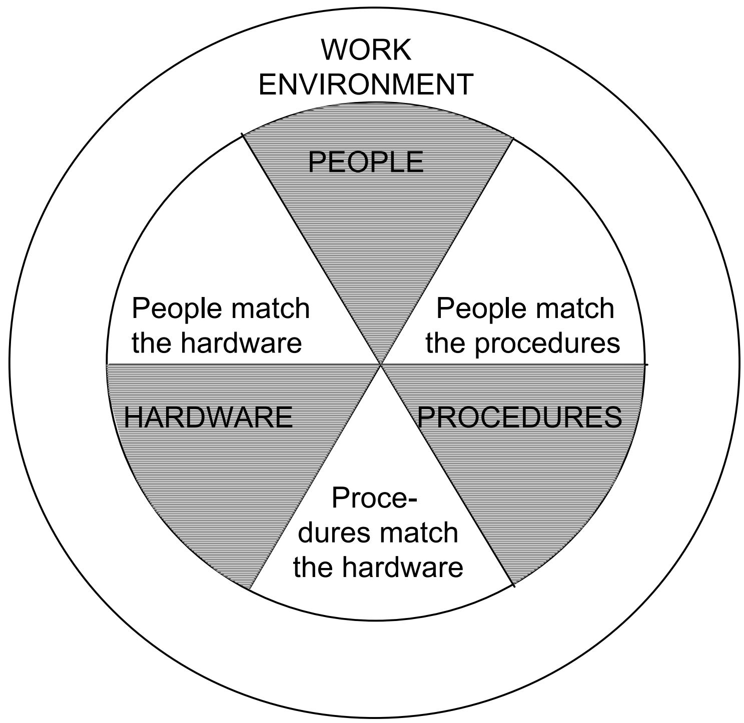


Fig. 12.1. The Safety Wheel

If you apply the steps of the JSA analysis and the ideas of the Safety Wheel to a specific job, you will end up with a list of items that you will need to address in order to do the job safely. A general checklist that could be applied to most jobs is printed on the back of the SWP Continuation Form (see page 397).

You must appreciate that this list is not the planning process; it is merely a reminder sheet. On some jobs, you may have to go back to basics to be able to identify the items that you need to consider.

WORK PLANNING SPECIFICS

You can see from the list on 397, that there are many things you should consider in the planning of work. The following sections will discuss some of them.

1. Identify the Hazards

When the first steps of the JSA have been completed, when the exact nature of the job is understood, and when the job has been broken down into its separate steps, then the hazards can be identified. Avoid the common errors of making the breakdown so detailed that an unnecessarily large number of steps result, or so general that basic steps are omitted. Record each step of the job in the order it is to be done. Record **what** is to be done, not **how** it is to be done.

Then carefully examine each step of the job to determine the possible hazards. It is very easy to miss significant hazards. An example of this occurred when some maintainers had to fix a beetle in a deep and narrow sump. Although they used all the Confined Space Entry procedures correctly, they forgot that this sump had contained moderator water, even though it now appeared to be dry. As a result, they exposed themselves without protection to airborne tritium levels equivalent to 125 mSv/h.

The IDENTIFY HAZARDS section of the checklist on page 397 is reproduced below to point out some of the hazards you might find at Point Lepreau G.S.

IDENTIFY HAZARDS	– Gamma – Beta – Neutron – Tritium – Particulates – Radioiodines – Noble Gases	– Radiation Beams – Loose Contamination – Confined Space – Oxygen Deficiency – Toxic Substances – Explosive Gas – Heat Stress	– Electrical – Chemical – Steam – Fire – Noise – Falls – Contained Energy

2. Control the Hazards

Ask yourself what can be done to control the hazard. Do you remember the Safety Precedence Sequence from page 177? There we pointed out that some ways of reducing hazards are more effective than others. Obviously, the most effective way is to eliminate the hazard, and the least effective way is to do nothing. The sequence below is repeated from page 177: it lists the things you can do, in decreasing order of effectiveness, to control a hazard.

1. Eliminate the hazard
2. Minimise the hazard
3. Install physical barriers
4. Install warning devices
5. Minimise human error potential
6. Establish procedures
7. Train, motivate and supervise personnel
8. Accept the hazard as it exists

Let us look at each of these ideas in turn to see how you might use them.

Eliminate the Hazard

In many cases this is easy to do by de-energising the system before you work on it. Examples are opening a breaker before you work on electrical equipment, and depressurising and cooling down gases and liquids before opening the system containing them.

Minimise the Hazard

This means minimising the effect of the energy source, even if we can't eliminate it entirely. In some cases, the answer is obvious, such as storing a heavy object on a low shelf rather than a high one. In other cases, it may be less obvious: when you use a drill or other power tool, don't choose a more powerful tool than you need for the job. If a powerful tool binds, it could twist you around and cause an injury or fall.

Install Physical Barriers

Physical barriers separate you from the energy source, so that an uncontrolled release of energy cannot harm you. Whenever possible, you should use several barriers so that the loss of a single barrier won't result in an injury. For example, when you have to work at a height, a good work platform minimises the chance of falling, the harness and lanyard will arrest any fall, and an independent fall line will ensure that you don't fall even if the work platform does. Using all three barriers is obviously better than just using one.

Use Warning Devices

Warning devices alert you to increasing hazard levels, so that you can retreat and re-assess the hazard. For example, PADs will warn you of changing radiation fields; an oxygen monitor will warn you of a change in the oxygen content of the air. Signposting is another, but less effective, example of warning devices.

Minimise Human Error Potential

Make sure that you consider the people-equipment and people-procedure interfaces of the Safety Wheel when planning a job or writing procedures for it. Many of the people-equipment interfaces should have been addressed in the design of the station and its equipment. For example, the upper button on crane controls should raise the hook, and the lower button should lower it.

When you plan a job, make sure that the simple and easy way of doing it is the correct way, or at least will not get the worker into trouble. For example, the environment in which he must work can be designed to minimise the potential for error by providing adequate lighting, suitable work/rest schedules, the correct tools, and easily understood job plans. Don't set the guy up by making it difficult for him to do the job right.

Establish Procedures

Written procedures provide step-by-step instructions that detail the correct and approved method of doing a job. Procedures should be reviewed to make sure that they are correct. They are very useful in ensuring that jobs are done safely and consistently. The major weakness with procedures is that there is no guarantee people will follow them exactly. That is why they are fairly low on the list of effectiveness of safety measures.

Train, Motivate and Supervise Personnel

Training, motivation and effective supervision are important parts of any job. They are low on the list, because they depend on memory, experience, maturity and judgement. Often a worker's training and experience does not apply exactly to the situation at hand.

Accept the Hazard as it Exists

In some cases, you may decide to accept the hazard after some or all of the items above have been considered. First, it is impossible to make anything absolutely safe, and second, to make it safe for one person may entail more risk to others. For example, is it reasonable to ask three people to spend an hour at a height to build a work platform for a half-hour job for one guy?

When you ask yourself what you can do to minimise and control hazards, the following checklist may be helpful.

CONTROL THE HAZARDS	– Remove Hazard – Delay Work – Install Shielding – Increase Distance	– Install Barriers – Decontaminate – Ventilate – Plastic Tent	– Rubber Area – Rubber Change Area – Work Platform – Waiting Area

3. Make the Job Easier

Once you have identified the job steps, you can look at ways of making the job go more smoothly. The following list may give you some ideas on how to do this.

MAKE IT EASIER	– Previous Job Reports – Work Plan – Hazard Info	– Rehearsal – Mock-ups – No Unnecessary Work	– Work/rest Schedule – Protection Assistant – Special Tools

Make sure that you identify all tasks that have to be completed before the job can be started. Previous work plans and work reports can often help you to find ways of simplifying the job. You can use the HAZARD INFO system to get information on previous conditions.

Make sure that all necessary tools are available and in good condition. Use tools from Contaminated Stores for jobs on contaminated systems. Consider the option of fabricating special tools that will simplify the work.

Rehearsals and mock-ups are very effective means of identifying potential problems in your work plan. Mock-ups are full-scale dress rehearsals with identical equipment in low hazard areas. For complicated work in high radiation fields, mock-ups are a crucial ALARA requirement.

For example, a complete mock-up of a boiler head was first built for the 1985 maintenance outage, so that we could test the procedures for removing manhole covers, as well as those for boiler entry and exit. This has saved us saved considerable dose over the years, because the proper tools and equipment were identified, and the work could be done faster because it had been practised in the mock-up.

Complex jobs may make it inefficient or inconvenient for qualified staff to look after their own radiation protection while doing the job. In these cases, a **Protection Assistant** (PA) is often used to supervise and expedite the radiation protection aspects of the job. He would monitor the radiation conditions, and ensure that imposed time and dose limits are not exceeded. Also, he would arrange for adequate supplies of protective clothing and equipment, regularly survey the work area and anticipate changing conditions, help workers dress and undress, control contamination, housekeeping and active waste. If the PA thinks it is necessary, he can stop the work. Occasionally, we will have a need for radiation work to be done by outside contractors. Their staff will also need a green-qualified PA to provide radiation protection for them.

4. Instruments and Surveys

Your plan should include details of all measurements that are required, namely what kind, where, when and by whom.

INSTRUMENTS & SURVEYS	– Gamma Meter – Beta Meter – Neutron Meter – Contamination Meter – Portable AGM	– Portable Air Sampler – Bubbler – Cont. Air Monitor – Port. Tritium Monitor – AAGM Set-points – Scintrex	– AATM Set-Points – Oxygen Detector – Toxic Gas Survey – Explosive Gas Survey – Heat Stress Survey – Extension Cables

Make sure that all instruments are checked before use. Surveys should be done before the work begins. The person doing the job should verify the conditions periodically during the job. He should also re-survey after any step that might change the hazards (e.g., opening a system).

5. Signposting

Signposting warns everybody of the hazards at a particular work location, so that nobody gets any surprises, especially those not involved with the job. Some of the signs that you may need are:

SIGNPOST HAZARD	– Danger – Restricted Rad. Area – Explosive Gases – Electrical Hazard – Steam Leak	– Caution – Radiation Area – Rubber Area – Rubber Change Area – Hot Spot	– Slippery Floor – Hot Environment – Men Working Above – Airborne Hazard – Tripping Hazard – Opening in Floor

It is important to remember that signs should be updated frequently. They should also be removed promptly when the hazard is no longer present. You rapidly become desensitised to signs if they don't provide you with useful information.

6. Dosimetry

The type of hazards you anticipate will dictate the required dosimetry.

DOSIMETRY	– Extremity TLDs – Neutrons	– PAD – Urine Sample – Non-uniform Exposure	– Dose Estimates – Dose may exceed DCP

You have to wear a PAD whenever you enter a Zone 3 area. Your PAD gives you a continuous readout of the dose received, and it will alarm when pre-set levels of dose or dose-rate are reached (see page 167 – 169). Also, we can use PADs for dose accounting for specific jobs, merely by setting up a special job code for that job.

If orange-qualified workers are expected to receive neutron doses of 0.2 mSv or more, you have to replace their regular TLD with a neutron-insensitive TLD for the duration of the job (see page 165).

For extremity gamma doses expected to be ten or more times greater than the external whole-body dose, you will need extremity TLDs. You will also need them if you expect the beta dose-rate at the extremities to be greater than at the torso. (Absorption of the betas in the air space between the extremities and the torso TLD will cause the torso TLD to read low for the extremity dose.)

If you anticipate working in high levels of contamination, you should make sure that all dosimetry devices you intend to wear are bagged in a zip-lock bag. If the work is likely to lead to tritium uptakes, be sure that you specify urine samples before as well as after the job. Why?

If your anticipated whole-body dose (gamma + neutron + tritium) is likely to exceed your DCP, special restrictions apply. An SWP approved by the Shift Supervisor and Health Physics is required for anticipated doses above the DCP.

There may be times when you expect to be exposed to non-uniform radiation fields in the sense that the dose rate at your head, for example, may be several times greater than that at the normal TLD badge location on your torso. In such cases, it may be appropriate to wear two badges, one on your torso and one on your head. This is a special dosimetry procedure requiring Health Physics assessment and approval.

7. Protective Clothing and Equipment

The use of protective clothing and equipment provides a barrier between you and the hazard. Your plan should specify what protective clothing and equipment are required. Make sure that your plan calls for the right equipment in sufficient quantities. Below is a reminder of what we have available.

PROTECTIVE CLOTHING	– Browns – Dispos. Coveralls – Dispos. Booties	– Plastic Suit – Fire Approach Suit – Chemical Suit	– Special Gloves – Winter Clothing
PROTECTIVE EQUIPMENT	– Fall Arrest System – Ear Protection – Eye Protection – Fire Extinguisher – Retrieval Mechanism	– Air-purifying Resp. – Air-supplied Resp. – Air-supplied Hood – Scott Air Pack – Egress Air Supply	– Electrical Grounds – Rubber Sheet – Voltage Tester – GFI – Communications

If you identify any unusual needs during the planning of your job, contact Radiation Control for advice.

8. Manpower

A key factor in any job is manpower, or Human Resources, as our Personnel Department would prefer us to call it. We couldn't do the job without them. Some of the things to consider are:

MANPOWER	– Protection Assistant – Special Training – NEW Status – Available Dose	– Physically Capable – Define Responsibilities – Job Experience – Aware of Hazards	– Work Qualified – Rad. Work Approval – Advanced 1st Aid/CPR

Some of the things that are often overlooked in job planning are the importance of defining specific roles and responsibilities. You have to make sure that all the people involved understand what their duties are in relation to the entire job. It is just as important to identify how the job will be supervised.

Have the workers done this type of job before, or is special training necessary? They must be physically capable of doing the work: don't ask a giant to crawl into small manholes, or person-holes as our Personnel Department...

If orange-qualified people are involved in radiation work, someone who is green qualified is going to be their Protection Assistant. This responsibility must be assigned to someone who understands what is required.

Anyone who is not an NEW cannot do radiation work without a Radiation Work Approval signed by the Station Health Physicist, who would specify the conditions applicable to non-NEWs. Station and attached staff who are not NEWs are listed as "NON-NEW" in the DCP column of the Bioassay Update Report (page 340). Without a Radiation Work Approval, their DCP is zero.

9. Before Work

Before the job begins, make sure that the prerequisites are complete and that the equipment is ready. Shortly before the job is due to begin, take the time to review the work plan with all workers, paying particular attention to the radiation and safety hazards. Make sure that they understand the plan, the hazards, and their specific duties **before** the job starts.

BEFORE WORK	– Review Plan – Contingency Plans	– Gather Equipment – Inspect Equipment – Pre-requisites Done	– Dose Limits – Dose-rate Limits – Time Limit

Limits are sometimes called for on a work plan to prevent excessive exposure, particularly for jobs in high radiation fields or for jobs during which the radiation conditions might change drastically. The PAD Reader normally sets these limits for the job when you initialise your PAD. In some cases, you might want to use a time limit if the fields are so high that the exposure can only be a short one. If you set limits, make sure that all workers understand what they are, and that they are supposed to leave the area when these limits are reached.

Contingency plans should be developed when applicable. If things go wrong, it may not be possible to merely retreat (except perhaps for a short time) – some prompt corrective action may be required that can't wait. When there is a risk that an unwanted event may occur and cause an unacceptable condition, a contingency plan should be prepared for handling this situation.

Here is an example of an inadequate pre-job briefing. The job was to disassemble a primary heat transport fitting. It had been extensively planned with specialised equipment available for controlling the high levels of contamination that were anticipated. The planning process went smoothly – the job was not of mind-boggling complexity. But unfortunately the pre-job briefing was inadequate and the job was started without the Protection Assistant assigned to the job. This resulted in a deviation from the plan, which caused extensive contamination to be spewed all over the place. The necessary clean-up took a lot of man-hours, and this was during a shutdown when there were definitely more useful things to do. Later repetitions of the job followed the plan exactly, and there were no problems at all. How about that?

10. During Work

DURING WORK	– Monitor Conditions – Changing Conditions – Check PAD Regularly	– Minimise staff – Supervise Job	– Housekeeping – Contamination Control – Airb. Contam. Control

All the effort devoted to planning a job is wasted if the plan is not followed. If you are confronted with inconsistencies between the situation at hand and the plan, do not make assumptions. Stop, and notify the Job Supervisor or the Shift Supervisor.

Monitor the hazards periodically during the job, particularly when your activities might cause a change in conditions. Make sure that you comply with the limits specified in the plan, and that only essential people are allowed in the hazardous area.

Also, it is important to use good housekeeping practices, so that you don't create additional hazards or spread contamination during the course of the work.

11. After the Job

The plan should describe all activities needed to restore the work site back to normal, as well as all the administrative details to wrap the job up.

AFTER WORK	– Clean up Area – Decontaminate Tools – PAD Dose Recorded	– Extremity TLDs – Urine Sample – Neutron DIF	– Permit Surrendered – Hazard Info Entry – Log Entries – Work Report

The job is not finished until the area is cleaned up and all materials used for the job are removed. Take the waste material to active waste. Take reusable items to their appropriate location. Tools should be returned to the Tool Crib, respirators and plastic suits to the Plastics Laundry.

Submit a DIF for any neutron dose. Put extremity TLDs in envelopes and leave them in the Work Control Area for Health Physics to collect. Submit urine samples (see page 242 for when). If there has been any radioiodine contamination, a check on the self-serve thyroid monitor is a good idea.

Complete and surrender the Work Permit (and the SWP if it was used). Enter useful information in the HAZARD INFO system or the Station Log as required. Hold a debriefing meeting with all those involved to identify problems that can be resolved before the job is done again. And finally, write a Work Report to record significant observations and results.

SAFETY WORK PLAN

An SWP and a SWP Continuation Form (CF) are used together with a PLGS Work Permit (WP) to ensure that all hazardous jobs are given an extra measure of pre-planning. AN SWP is authorised jointly by the Shift Supervisor and Health Physics. The WP/SWP package may be issued and suspended as many times as required, but each time it must be reissued by the CRO.

The SWP is usually prepared in advance by some person who has assessed the job. The Work Group Supervisor of the intended WP holder approves the SWP. The WP holder prepares the CF. It is used for dose control and to record air test results during confined space entries. The holder of the WP shall accept the SWP only after his Work Group Supervisor has briefed him, and only after he understands his duties and responsibilities with respect to the plan.

First, an example of the use of an SWP: the job is the task of back-seating ECC valve MV63 in the ECC Valve Gallery at 100% power. The SWP and Continuation Form for this job are shown on pages 394 and 396. Pages 395 and 397 show the back of the SWP and the back of the Continuation Form.

The requirements for when an SWP must be used are given on the back of the SWP form, i.e., page 395. You are expected to know these. There will be times when detailed work plans already deal with all the precautions that would otherwise be addressed by an SWP.

For this reason, i.e., to avoid redundancy, an SWP will not be required when:

a) a formal work plan (or part of it) is specifically dedicated to the hazards of the job, and

b) Health Physics approves the formal work plan for use without an SWP. The work plan cover sheet must state that the plan replaces the need for an SWP.

POINT LEPREAU GENERATING STATION

SAFETY WORK PLAN

NOG FORM 1254 REV. 96-01

№ 15251

DESCRIPTION OF WORK	SYSTEM ECC	BSI 34320	UNIT 1	WORK PLAN NUMBER N/A

Access R1-107 ECC Valve Gallery El 86 West to backseat 3432-MV63
Holder must contact CRO before and after entry.

HAZARD ASSESSMENT				
	RADIATION ☑	CONFINED SPACE ☐	HEAT STRESS ☐	FALLS ☐
	ELECTRICAL ☐	COLD ENVIRONMENT ☐	CHEMICAL ☐	OTHER (SPECIFY)____ ☐

SURVEY REQUIREMENTS	RADIATION SAFETY		INDUSTRIAL SAFETY	READINGS	BADGE #
GAMMA	1-2	mSv/h	WBGT INDEX	°C WBGT	
BETA		mSv/h	AMBIENT TEMPERATURE	°C	
NEUTRON	10 - 40	mSv/h	OXYGEN	% O_2	
TRITIUM	unknown	mSv/h	EXPLOSIVES	% LEL	
IODINE		mSv/h	TOXIC SUBSTANCES		
PARTICULATES		mSv/h			
CONTAMINATION		cps			

PROTECTIVE MEASURES — The following is provided as a general check list. Further information can be found on the back of this form set.

RESPIRATORY PROTECTION ☐	TIME LIMITS ☑	COMMUNICATIONS EQUIPMENT ☐
VENTILATION ☐	SPECIAL DOSE LIMITS ☑	SAFETY PERSON(S) ☑
PROTECTIVE CLOTHING ☑	PERIODIC HAZARD ASSESSMENT ☐	DOSE CONTROL DESK ☐
FALL ARRESTING DEVICE ☐	CONTINUOUS MONITORING ☐	OTHER
TEMPORARY BARRIERS ☐	ADDITIONAL DOSIMETRY ☑	(SPECIFY)____ ☐

SPECIFIC REQUIREMENTS

Neutron Meter
Rad Control Person to act as Safety Man
Time limit of 5 mins for entry
Plastic Suit (because of leaking packing gland)
PADs to be set for 3.0 mSv/h and 0.3 mSv total dose
Need Access Key 22 and Access Override Key.

SAFETY WORK PLAN CONTINUATION FORM	ISSUED	ISSUED	ISSUED	ISSUED	ISSUED	ISSUED	ISSUED
	No. 8023	No.	No.	No.	No.	No.	No.
	SURRENDERED	SURRENDERED	SURRENDERED	SURRENDERED	SURRENDERED	SURRENDERED	SURRENDERED
	No.	No.	No.	No.	No.	No.	No.

PREPARED BY	SIGNATURE George Lewis	TIME 13:00	DATE 89-12-07	HEALTH PHYSICS APPROVAL C.F.N.Baker
APPROVED BY	WORK GROUP SUPERVISOR Sammy Harrington	TIME 09:00	DATE 89-12-09	
ACCEPTED BY	WP HOLDER SIGNATURE J Dodds	TIME 10:00	DATE 89-12-10	WORK PERMIT NUMBER
ISSUE AUTHORIZED	SS SIGNATURE Sidney Becker	TIME 10:08	DATE 89-12-10	12345

Distribution: 1) WHITE and PINK, attach to the same colour page of the Work Permit.
2) YELLOW, Health Physics Out Basket on completion.

Fig. 12.2. Safety Work Plan Form

An SWP SHALL be used whenever:

1) It is expected that a person's DCP may be exceeded.
2) The total dose for a particular job is expected to exceed 20 man-mSv.
3) The override key is required for entry to Access Controlled areas, subsystem A or B (not applicable Reactor Power <2%).
4) Work is to be performed in any atmosphere that is immediately hazardous to life or health (IDLH) (e.g. low oxygen conditions, toxic atmospheres).
5) When OM-03400 Procedures set up to control hazards cannot be followed.
6) Hazardous work is being done and is not addressed in OM-03400.
7) Work requiring tools or equipment inserted/removed from Reactor Core or Biological Shield.
8) Use of SCBA other than for emergencies or training.

RADIATION OM-03400	Plastic suit Cartridge respirator Air-supplied respirator Air-supplied hood Disposable coveralls Shoe rubbers	Rubber Area Rubber Change Area Shielding Decontamination Communications Remote tools Rehearsal	Extremity TLDs Neutron meter Urine samples Thyroid monitor Body count
HEAT STRESS OM-03400 : IS-6	If ambient temperature is greater than 30°C there is a 2 hour work limit when wearing a plastic suit Increase fluid intake	Heat stress survey Work/rest schedule Rest in cooler area Rest when stress symptoms occur	Fire approach suit Local cooling
CONFINED SPACE OM-03400 : IS-5, 20	Oxygen/combustible gas test Contents of space (Toxic Substances)	Ventilation Continuous air monitoring Airline with escape bottle Retrieval Equipment	Low voltage tools Local Ground Fault Interrupter Safety person(s) Mechanical isolation of equipment
FALLS OM-03400 : IS-12, 13, 14	Harness & lanyard Rope grab lifeline	Retractable lifeline Safety barriers	Scaffold Mobile upright scaffold

JOB SAFETY ANALYSIS

1) Define the job
2) Break the job into steps
3) Identify the hazards
4) Apply the necessary controls

SAFETY WHEEL

Do the people, hardware and procedures match the work environment?

Look for hazards within each sector and at the interfaces between each sector.

EFFECTIVENESS OF SAFETY MEASURES

1) Eliminate the hazard
2) Minimize the hazard
3) Install physical barriers
4) Use warning devices
5) Minimize human error potential
6) Establish procedures
7) Train, motivate and supervise personnel
8) Accept the hazard as it exists

Fig. 12.3. Back of Safety Work Plan Form

POINT LEPREAU
GENERATING STATION

SAFETY WORK PLAN
CONTINUATION FORM

NOG FORM 1254C REV. 96-08

№ 8023

JOB IDENTITY	WORK PERMIT NUMBER	SAFETY WORK PLAN NUMBER	WORK PLAN NUMBER
	12345	15251	N/A

EXISTING CONDITIONS	Specify the conditions existing at the time of issue or reissue.
Work Permit Holder J. Dodds	100% Reactor Power
Date 59-12-10	
Work Permit Holder	
Date	
Work Permit Holder	
Date	
Work Permit Holder	
Date	

DOSE CONDITIONS

The Shift Supervisor and Health Physics approval are required for exceeding DCP.
Senior Health Physicist approval is required if expected doses are greater than twice the DCP.

NAMES (Please Print)	Current PAD Dose (mSv) +	External Dose Expected (mSv) +	H-3 Dose Expected (mSv) =	Total Dose Expected (mSv)	Posted DCP	Approval to Exceed DCP	Job Dose PAD (γ,–)
J. DODDS	0.23	1.5	–	1.73	8.24		
W. FAWKES	0	1.5	–	1.50	9.62		

Distribution: 1) WHITE and PINK, attach to the same colour page of the Work Permit.
2) YELLOW, Health Physics Out Basket on completion.

Fig. 12.4. Safety Work Plan Continuation Form

PLGS SAFETY CHECKLIST

IDENTIFY HAZARDS	– Gamma	– Radiation Beams	– Electrical
	– Beta	– Loose Contamination	– Chemical
	– Neutron	– Confined Space	– Steam
	– Tritium	– Oxygen Deficiency	– Fire
	– Particulates	– Toxic Substances	– Noise
	– Radioiodines	– Explosive Gas	– Falls
	– Noble Gases	– Heat Stress	– Contained Energy
CONTROL THE HAZARDS	– Remove Hazard	– Install Barriers	– Rubber Area
	– Delay Work	– Decontaminate	– Rubber Change Area
	– Install Shielding	– Ventilate	– Work Platform
	– Increase Distance	– Plastic Tent	– Waiting Area
MAKE IT EASIER	– Previous Job Reports	– Rehearsal	– Work/rest Schedule
	– Work Plan	– Mock-ups	– Protection Assistant
	– Hazard Info	– No Unnecessary Work	– Special Tools
INSTRUMENTS & SURVEYS	– Gamma Meter	– Portable Air Sampler	– AATM Set-Points
	– Beta Meter	– Bubbler	– Oxygen Detector
	– Neutron Meter	– Cont. Air Monitor	– Toxic Gas Survey
	– Contamination Meter	– Port. Tritium Monitor (Overhoff)	– Explosive Gas Survey
	– Portable AGM		– Heat Stress Survey
		– AAGM Set-points	– Extension Cables
		– Scintrex	
SIGNPOST HAZARD	– Danger	– Caution	– Slippery Floor
	– Restricted Rad. Area	– Radiation Area	– Hot Environment
	– Explosive Gases	– Rubber Area	– Men Working Above
	– Electrical Hazard	– Rubber Change Area	– Airborne Hazard
	– Steam Leak	– Hot Spot	– Tripping Hazard
			– Opening in Floor
DOSIMETRY	– Extremity TLDs	– PAD	– Dose Estimates
	– Neutrons	– Urine Sample	– Dose may exceed DCP
		– Non-uniform Exposure	
PROTECTIVE CLOTHING	– Browns	– Plastic Suit	– Special Gloves
	– Dispos. Coveralls	– Fire Approach Suit	– Winter Clothing
	– Dispos. Booties	– Chemical Suit	
PROTECTIVE EQUIPMENT	– Fall Arrest System	– Air-purifying Resp.	– Electrical Grounds
	– Ear Protection	– Air-supplied Resp.	– Rubber Sheet
	– Eye Protection	– Air-supplied Hood	– Voltage Tester
	– Fire Extinguisher	– Scott Air Pack	– GFI
	– Retrieval Mechanism	– Egress Air Supply	– Communications
MANPOWER	– Protection Assistant	– Physically Capable	– Work Qualified
	– Special Training	– Define Responsibilities	– Rad. Work Approval
	– NEW Status	– Job Experience	– Advanced 1st Aid/CPR
	– Available Dose	– Aware of Hazards	
BEFORE WORK	– Review Plan	– Gather Equipment	– Dose Limits
	– Contingency Plans	– Inspect Equipment	– Dose-rate Limits
		– Pre-requisites Done	– Time Limit
DURING WORK	– Monitor Conditions	– Minimize staff	– Housekeeping
	– Changing Conditions	– Supervise Job	– Contamination Control
	– Check PAD Regularly		– Airborne Contam. Control
AFTER WORK	– Clean up Area	– Extremity TLDs	– Permit Surrendered
	– Decontaminate Tools	– Urine Sample	– Hazard Info Entry
	– PAD Dose Recorded	– Neutron DIF	– Log Entries
			– Work Report

Fig. 12.5. Safety Checklist (Back of SWP Continuation Form)

WORK PLANNING EXAMPLE

Now that you have seen the tools, we're going to show you an example of job planning to give you an idea of how it all fits together.

A model of such a work plan is the one that is used to remove the Ewing spool piece from the moderator purification circuit to guarantee reactor shutdown.

The spool piece is a piece of connecting pipe in the moderator purification circuit. When it is removed, and when the ends of the piping are capped, there is no purification flow and the moderator poison injected by Shutdown System #2 cannot be removed. Hence the shutdown is guaranteed. The spool piece was named the Ewing spool piece in honour of Bernie Ewing, the CNSC's representative at Point Lepreau until 1989, because he used to insist that we go through this procedure. Thanks a whole bunch, Bernie.

The Radiation Protection Plan for the spool piece caper is reproduced on pages 399 - 401. Although it is quite dated, it was a good example of the sort of detail that is required in a decent plan. It has since been incorporated in the Mechanical Maintenance Procedure for this job. If you can think of anything missing, please pass the word to Radiation Control.

PLANNING UNDER UNUSUAL CONDITIONS

It is commonly assumed that prompt action rather than planning is more important during unusual or emergency conditions. Often the opposite is true. Action without forethought can worsen rather than improve a situation (you have all heard of attempts to rescue someone overcome by fumes in a confined space – only to have the would-be rescuer added to the fatality list).

Some emergency situations that may arise have been anticipated. They will be handled by contingency plans that have been prepared in advance. This topic will be covered in the next chapter. Other emergency situations may not have been identified previously, and no contingency plan will exist for them. Even so, there are very few emergencies that require such urgent action that no real planning can go into the response.

Health Physics Bulletin 83-06 on page 401 gives an example of how an undesirable event was resolved in an appropriate manner. It is worth noting that the entire caper was handled by the Duty (evening) Shift in consultation with Fuel Handling.

Much of the process of thinking a job through, testing your plan and executing the job according to plan is common sense. In most cases the time spent planning is more than compensated by the time saved in actually doing the job (even though the time and dose you save may be someone else's, we all play on the same team).

HP-070

HP-095

POINT LEPREAU GENERATING STATION

RADIATION PROTECTION PLAN

Removal of the Ewing Spool Piece
from the Moderator Purification System.

It is intended that this detailed Radiation Protection Plan removes the requirement for a SWP.

Prepared By: Chris Philip Date: 87-04-23

Approved By: R. A. Munro Revision 4

OVERVIEW

This job involves the removal of the Ewing spool piece from the Moderator Purification system in order to guarantee reactor shutdown. The following plan details the hazards involved and the required protection. No Protection Assistant will be required since green qualified Mech. Maint. staff will do the work.

The major hazard to expect is high tritium levels in the event of a spill: 25,000 – 50,000 DAC. The equivalent external dose rate for unprotected exposure to such H-3 levels is 250-500 mSv/h! Gamma fields in S1-005 should decay to below 25 μSv/h soon after reactor shutdown; however the D_20 piping should be checked for hot spots. If no water is spilled, contamination on the floor should be zero. After a spill expect 20-30 cps on the floor.

To minimize these hazards the following procedures shall be used:

DOSIMETRY
- Urine samples before and after the job.
- Regular TLD badge and PAD to be worn.

PROTECTIVE CLOTHING
- Full air-supplied plastics to be worn.

RADIATION MONITORING
- Have a Scintrex monitor in the room at all times. Check for tritium outside the room occasionally.
- Check contact gamma on the D_20 piping in vicinity of the work area. Shield hotspots with lead blankets.

CONTAMINATION CONTROL
- Rubber station set up outside entrance with frisker.

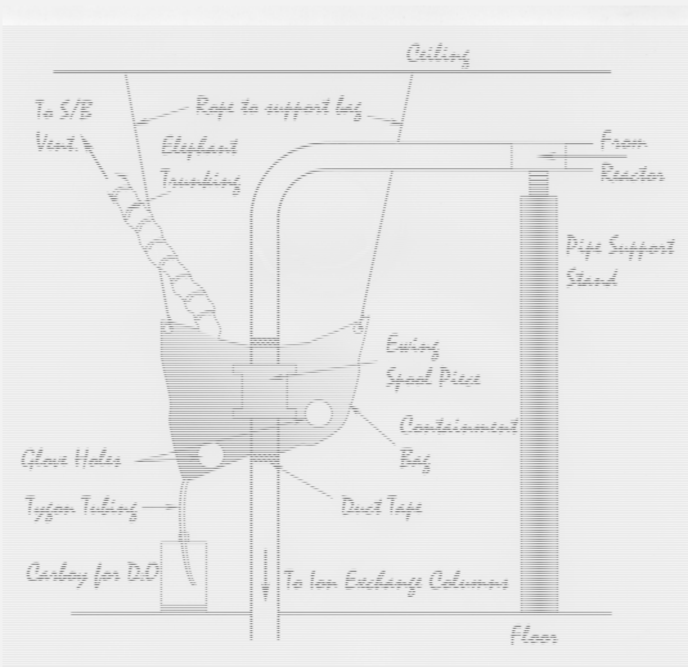
TRITIUM CONTROL
- Local ventilation to be set up at source of H-3, i.e., spool piece.
- Have spool piece containment bag available (from Rad. Cont.).

PREREQUISITES

1. Place support stand under valve 1-3221-V3. Turn adjusting screw to apply tension (stand is located in S1-005).

2. Disconnect hanger rods from riser clamp. Tie hanger rods back away from the spool piece.

3. Install the containment bag around the spool piece (see diagram). Put the appropriate wrenches and pipe blanks inside the bag before zipping bag closed.



CONTAINMENT BAG ARRANGEMENT

4. Set up Rubber Area outside entrance to S1-005.

5. Connect an empty carboy via Tygon tubing to the bottom of the containment bag for D_2O collection.

6. Obtain the following instruments for the job: frisker, Scintrex, H-3 Monitor, gamma meter. Ensure that they have been source checked, etc.

7. Ensure that Room S1-005 is properly ventilated, i.e., check that the ventilation damper is fully open. Connect elephant trunking to a S/B ventilation system duct and run it into the Purification Room so that local ventilation is available at the spool piece (i.e., to remove tritiated water vapour at the source). A Jumper Record will be required from Work Control.

SPOOL PIECE REMOVAL

1. Signpost S/B elev. 25' with CAUTION signs, i.e., "Possible airborne tritium due to work on Moderator D_2O system".

2. Put on air-supplied suit before entering S1-005.

3. Remove spool piece using the gloves in the containment bag. If the bag should leak (for whatever reason), wipe up the D_2O ASAP, and transfer the carboy.

4. After the spool piece is removed and pipe blanks have been installed, transfer any D_2O remaining in the containment bag to a carboy. Enclose the containment bag plus spool piece and any rags or sponges used for wiping up spills into an "ACTIVE WASTE" bag, and seal with duct tape.

5. Remove plastic suits at the Rubber Area barrier, put them in a "LAUNDRY" bag, and transfer to Plastic Laundry.

6. Frisk all tools and equipment used in the Rubber Area.

7. Transfer all D_2O carboys to D_2O Mgt. and label accordingly.

8. Transfer the wet rag and spool piece to the fume hood in Zone 3 Mech. Shop. Rinse contents of the bag thoroughly with light water. Monitor for tritium with a Scintrex. Let these items dry in the fume hood for a few days. Signpost accordingly.

SPOOL PIECE REPLACEMENT

1. Put on air-supplied suits before entering S1-005.

2. Remove pipe flanges and place spool piece back in the system. Keep ventilation exhaust hose as close to open pipe as possible until the system is closed up again. WIPE UP SPILLS AND TRANSFER TO CARBOY ASAP.

3. Enclose all rags and sponges used for wiping up spills in an "ACTIVE WASTE' bag and seal with duct tape.

4. Remove plastic suits at the R/A barrier and put them in a "LAUNDRY" bag and transfer to Plastics Laundry.

5. Frisk all tools and equipment that were used in the Rubber Area.

6. Transfer all D_2O carboys to D_2O Mgt. and label accordingly.

7. Transfer the wet rags/sponges to the fume hood in Zone 3 Mech. Shop. Rinse contents of the bag thoroughly with light water. Monitor for tritium with a Scintrex. Let these items dry in the fume hood for a few days. Signpost accordingly.

8. Dismantle Rubber Area and check the floors for loose contamination with a Masslinn mop.

9. When the rags/sponges are dry, dispose of them into an active waste container.

HEALTH PHYSICS INFORMATION BULLETIN 83-06

An Example of Good Job Planning

A drip tray installed below the West Fuelling Machine came loose on #3 shift on June 7. This prevented the F/M from discharging spent fuel because the drip tray would now interfere with the work platform permanently located at the north end of the F/M Maintenance Lock (R1-103). The platform had to be dismantled so that the West F/M could discharge the eight bundles it contained.

The F/M was cooling the fuel and none of it was defective. The Shift Supervisor and the Fuel Handling group decided that enough time was available to plan the job carefully, so that it could be done safely with the reactor held at 100% power.

There were two problems:

1. The shielding door between the West F/M Vault and Maintenance Locks was open.
2. With eight bundles in it, contact gamma fields at the snout of the F/M are known to be of the order of 100 Gy/h.

The job was well planned and rehearsed:

- The F/M was moved to the top row of channels, so that it was "hidden" from the platform by the roof of the Maintenance Lock.
- Six Fuel Handling people rehearsed the dismantling on a similar platform in the East Maintenance Lock where the shielding door was closed.
- Fields at the work location were measured at 6 mSv/h gamma and about 6 mSv/h neutrons.
- The platform was dismantled in 80 seconds by using three pairs of guys, one pair at a time.
- The highest DRD reading was 0.2 mGy.

The message is that when a job is well planned and well executed, doses can be held to low levels, even if at first glance the job appears impossible to do.

Date	*Incident*
98-01-03	Outage. Following removal, SDC pump seal placed in Decon Centre. RC Tech survey found 2 mSv/h contact on seal. Told MM to shield (lead blankets) and update sign.
98-01-28	Rad waste bag found in S1-129 (Rad Waste Room) 5 – 7 mSv/h contact, not sign-posted, shielded or logged in. Origin unknown. *Way to go, Homer.*
98-06-12	SFCR *(Single Fuel Channel Replacement)* worker wrist PAD showed max dose rate of 60 mSv/h during PT cutting operation. Reinforced with SFCR personnel the value of wearing PADs on extremities to alert them if reaching into beam (beam typically 600 mSv/h) during maintenance activities on the SFCR platform. *They would of course also wear PADs on their torso.*
99-07-03	Following Ice-Blast of boiler #2 PAs identified hot spot approx. 35 mSv/h. RC Tech survey results revealed hot spot to be 170 mSv/h (gamma). Hot particle removed by PAs to a leaded shielding container & work resumed in boiler primary side.

Internal Radiation

Date	*Incident*
87-06-19	Outage. Mechanic changing oil in lower bearing housing of a shutoff rod. When the lower oil plug was removed, vapour was released into the mechanic's breathing zone. The SOR lower seal between it and Moderator cover gas was passing. Uptake of mechanic = 2.4 mSv.
88-02-10	Two mechanics doing maintenance on Moderator Cover Gas compressor (work area enclosed in ventilated tent, both Mechanics initially in plastics). Scintrex indication showing approx. 250 μSv/h, so they decided to remove plastics and continue in respirators. When Scintrex finally totally failed (due to dead batteries) they obtained replacements. Indication then was approx. 38 mSv/h. They promptly dressed in plastics to continue the job. *No mention in log of dose received by mechanics.*
92-12-16	Two mechanics sprayed with Moderator D_2O. Job entailed running new vent lines from Moderator collection tank to Vapour Recovery Dryers 7&8 (original set-up was to Dryers 9 and 10, which service accessible areas of the R/B). Mechanics were to run (not tie in) new line only. Under System Engineer's direction mechanics cut into system (using hacksaw upstream of an existing swagelock cap) resulting in small spill of D_2O (<500 mL). Line was isolated using duct tape (later recapped with a swag lock fitting). Airborne H-3 in area after spill cleanup 140 μSv/h. Event Report generated as a result of above unauthorised work. *No mention in log of tritium uptake of mechanics.*
94-07-23	Outage. Mechanic sprayed with Moderator D_2O while working on Moderator pump seal (no plastics or gloves). Mechanic immediately went and showered; no further radiation work until approval by HP. *RP Procedure DC-17 says that Plastics **must** be worn when working with moderator water.*

Date	Incident
95-06-23	Outage. Contractor alarmed Portal Monitor on his way to Zone 1. Body count revealed 0.52 mSv internal contamination, mainly Co-60 and ZrNb-95. Investigation found he was working in the boiler cabinets with no respiratory protection. PAs told to closely monitor workers. (Seems this particular individual removed his respirator while in the cabinet. The PA was not aware of this action). *No mention in log of follow up actions taken.*
95-07-07	D_2O spill in D_2O management area from a leaking sample valve. Approx. 4 L on the floor. Operations had previously placed a 200 mL bottle under the leak (no ventilation) and either didn't appreciate the leak rate and/or didn't pass it over to the incoming shift, although a WORD had been raised to identify the fault. RC Tech noticed AATM indicating 124 μSv/h, discovered the problem, and notified duty SS who arranged cleanup of the spill and replacement of the valve.
97-07-22	S1-129 (Active Waste Room) attendant shredding empty bottles (plastic) from Chem Lab. Airborne H-3 in room rose to 9 mSv/h (AATM indication). Attendant alerted early by AATM. Bottles, although dry, were not labelled as to original contents. Area sign-posted and remainder of work completed in plastics.
98-01-28	Empty carboy (no cover) found in Service Bldg. Crane Hall by RC Tech. Scintrex indication at carboy spout 2 –3 mSv/h. Origin unknown. Carboy disposed to active waste.

Conventional Hazards

Date	Incident
84-04-26	Following surrender of a Work Permit, a mechanic was backing out a gag (jackscrew) on ECC P-2 suction valve PV-2 to render it available for service. The valve was under full instrument air pressure (unknown to him) and the jackscrew is not equipped with a stop when fully backed out. As a result the screw (which is an approx. 2" diameter by 16" length threaded rod) was backed out until it became a projectile just missing the mechanic (glancing off the right side of his check taking his safety glasses with it). *Fortunately the mechanic sustained no injury.*
84-09-12	Turbine hall light fixture (approx. 30lbs) fell striking floor near exciter end of the unit. Cause was stripped threads on hanger, also not equipped with safety chain. Investigation revealed all fixtures not equipped with safety chains. *Problem was remedied ASAP.*
89-02-19	Mechanic received electrical shock while setting up to do a weld in #3 feeder cabinet. Investigation revealed mechanic was holding the welding tip close to his ear (to hear purge gas flow). Due to excessive sweating, arc jumped giving him a shock that knocked him out for approx. 1-2 minutes. Mechanic taken to hospital and later released: no sustained injury.
89-10-19	Ice plug being formed in S1-005 for maintenance of 3221-PV11. Improper ventilation set up for N_2 vapour removal resulted in room becoming IDLH (O_2 measured as low as 17% at waist height). Ice plug operations stopped and adequate exhaust ventilation set up. No further problems encountered.

Date	*Incident*
94-07-25	B&W contractor suffered heat stress symptoms while working in boiler cabinet (in plastics). Escorted by PA to Station Nurse who advised fluid intake and a cool shower. Contractor was able to return to work following shift.
95-11-13	Near Miss – contractor moving aluminium tooling from R/B elevation 62.9 to 86 by passing it vertically by hand up very near the crane bus bars (600 V). Work stopped and those involved told to dismantle equipment that it could be transported by the stairs, or to make arrangements to transport by crane.
97-12-08	Feedwater heater 6B incident. The manway cover was removed from heater 6B in preparation for the 3/8 seal plate cover to be removed for internal inspection. Operations were in process of refilling boiler #4. The feedwater bank was not isolated (not checked in the field either). On start-up of the auxiliary BFP, the seal plate was blown off, large amount of water sprayed into elevation -5; also staging in close to the heater was displaced 10 - 15 feet as a result of the water velocity. *Fortunately no was in the immediate area and no one was hurt.*
99-05-29	Outage. Near Miss. Hammer dropped from Dousing hitting Electrical junction box bouncing onto the RM deck. The maintainer, while working near the hand railing, knocked his tool belt against it and dislodged the hammer from his tool belt. Investigation revealed no equipment damage and no one was in the immediate vicinity of the RM deck area at the time.

A couple of examples of bad planning, again taken from the Darwin site:

1. *Two West German motorists had an all-too-literal head-on collision in heavy fog near the small town of Gütersloh. Each was guiding his car at a snail's pace near the center of the road. At the moment of impact their heads were both out of the windows when they smacked together. Both men were hospitalized with severe head injuries. Their cars weren't scratched.*

2. *An unidentified English woman, according to the London Sunday Express was climbing into the bathtub one afternoon when she remembered she had left some muffins in the oven. Naked, she dashed downstairs and was removing the muffins when she heard a noise at the door. Thinking it was the baker, and knowing he would come in and leave a loaf of bread on the kitchen table if she didn't answer his knock, the woman darted into the broom cupboard. A few moments later she heard the back door open and, to her eternal mortification, the sound of footsteps coming toward the cupboard. It was the man from the Gas Company. "Oh," stammered the woman, "I was expecting the baker." The gas man blinked, excused himself and departed.*

SUMMARY

Good planning and execution of work plans requires teamwork. The cornerstone of success is good communications at the planning stage. You have been introduced to three fundamental concepts for planning and performing jobs safely; namely Job Safety Analysis, The Safety Wheel, and the Safety Precedence Sequence. Additionally, a Safety Checklist was introduced as a handy tool for reminding you of the things that you need to consider for safety, efficiency and minimum dose (ALARA).

Think a job through before you start it. Job Safety Analysis is a common sense approach that requires you to

1. *identify exactly what the job is,*
2. *break the job into simple steps,*
3. *examine each step for potential hazards, and*
4. *control those hazards.*

The Safety Wheel reminds you that any job involves people, equipment, procedures and the working environment. The interfaces between each must be examined to make sure that the job can be done in logical, common sense fashion.

Safety measures range from eliminating the hazard to doing nothing. Procedures and Training, although important, are not effective in themselves at preventing accidents because of their heavy reliance on human factors. The order of decreasing effectiveness is:

1. *Eliminate the hazard.*
2. *Minimise the hazard.*
3. *Install physical barriers.*
4. *Install warning devices.*
5. *Minimise human error potential.*
6. *Establish procedures.*
7. *Train, motivate and supervise personnel.*
8. *Accept the hazard as it exists.*

The Safety Checklist provided on the back of the SWP is simply a tool, not a substitute, for the planning process.

Another job that didn’t go according to the plan: In an issue of *Analyst & Consultant* magazine, the editors told of this story:

The Federal Aviation Administration has a unique device for testing the strength of airplane windshields, a gun that launches a dead chicken at a plane's windshield at approximately the speed the plane flies.

The theory is that if the windshield doesn't crack from the impact of the carcass it'll survive a collision with a bird during flight.

The British wanted to test a windshield on a brand-new, speedy locomotive they're developing. They borrowed the FAA's chicken launcher, loaded a chicken and fired. The ballistic chicken shattered the windshield, went through the engineer's chair, broke an instrument panel and embedded itself in the back wall of the engine cab.

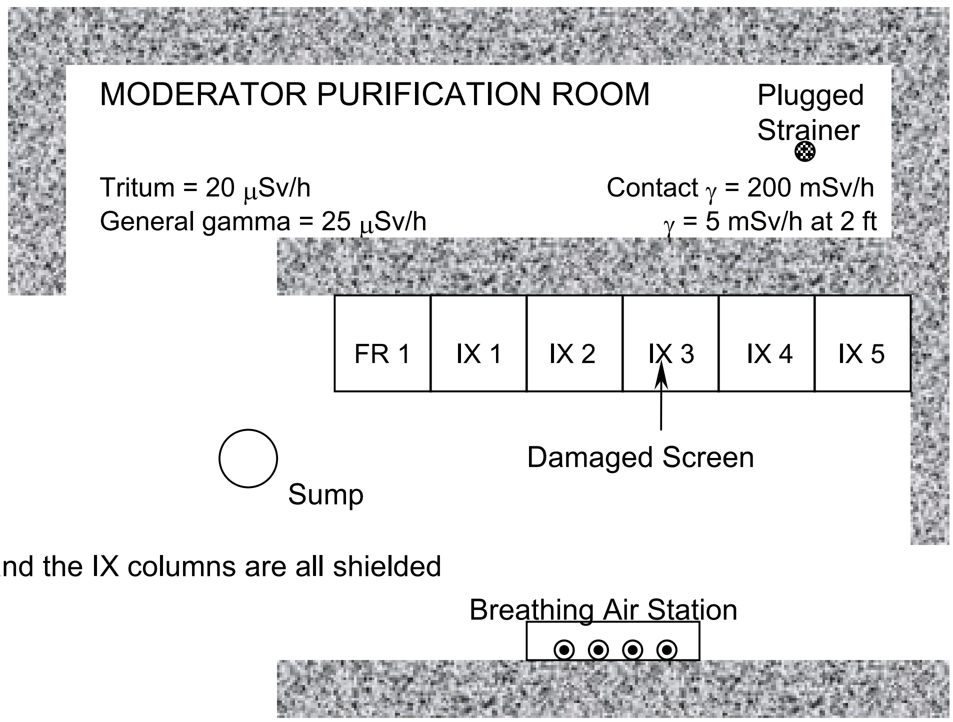
The British were stunned and asked the FAA to recheck the test to see if everything was done correctly. The FAA reviewed the test thoroughly and had one recommendation:

Use a thawed chicken.

PROBLEMS

Now you should practise writing a work plan. Here are four work situations that require proper planning. It is best if you do these exercises in a group of five or six, because the final plan will be much better than if you had tried to do it alone.

1. The diagram below shows a moderator clean-up room with five shielded ion exchange columns and one unshielded strainer. One column has a damaged screen. This has caused resin to escape and block the strainer, making the Moderator Purification Circuit unavailable for service. The strainer has to be cleaned, and you are the shift mechanic who has been selected to do it.



Note: FR 1 and the IX columns are all shielded

Prepare a work plan to do this. The top of the strainer must be removed and the inside screen must be cleaned of resin. The strainer cannot be completely drained. Gamma and tritium (bubbler) survey results are as shown.

2. A mechanism that has been used for several years to hold and position spent fuel in the inspection part of the Spent Fuel Reception Bay requires mechanical repair. It has been disconnected from its underwater mount, and will be raised out of the water and laid down on the floor beside the bay. The repair will require a fuel handler to work on the mechanism, with wrenches and other standard tools, for about half an hour. Prepare a detailed work plan for this job, beginning with the raising of the mechanism, and ending with the completed repair.

3. During a planned maintenance outage, we intend to do a dry inspection of pressure tube K-12 by inserting some electronic probes into the tube. Prerequisites for this work are that the channel has been defuelled, isolated by means of ice plugs, and drained of heavy water, with the shield plugs removed and closure plugs in place. Before the electronic probes can be inserted, the inside of the channel must be absolutely dry. Mechanical Maintenance has prepared several "swabs" consisting of soft, thick fibre washer assemblies, as shown here. They are a snug fit inside the pressure tube, and the intent is to push them through the tube to dry it out. Prepare a work plan for this job.