



**AUSTRALIAN NATIONAL COMMITTEE ON LARGE
DAMS**

**WORKING GROUP ON DAMS INDUSTRY
PROFESSIONAL DEVELOPMENT**

DRAFT REPORT

ON

**DAM INDUSTRY TRAINING AND DEVELOPMENT
NEEDS**

26th July 2009

VERSION C

1 INTRODUCTION

The Australian National Committee on Large Dams (ANCOLD) seeks to develop a position paper outlining the training and development needs of the Australian dams industry.

The position paper will provide a foundation on which ANCOLD can plan to support the provision of professional development opportunities for members.

Initially this will provide an input to the ANCOLD forward budget development. The position paper will be presented to the membership at the 2009 AGM and subject to members' endorsement, will underpin the development of a program of professional development opportunities for the ANCOLD membership.

To assist the ANCOLD executive in preparing the position paper a Working Group on Dam Industry Professional Development was established with representation of the range of membership and technical expertise. Membership for the Working Group is:

- Robin Fell – Academia / Geotechnical
- Norm Himsley – Regulator
- Phil Cummins – General Dams Engineering
- Stuart Richardson – Dam owner / Operations / Mechanical/Electrical Engineering
- Peter Hill - Consulting / Hydrology
- Peter Amos – New Zealand perspective

The brief for the Working Group is attached in Appendix A.

2 METHODOLOGY

The Working Group met in Melbourne on 20th July 2009. The Agenda for the meeting is attached in Appendix B.

A draft report was then prepared and circulated to Working Group members and to the ANCOLD Secretariat for review and comment.

A final report of the Working Group was then prepared taking account of these reviews and comments.

3 ANCOLD TARGET AUDIENCES

The ANCOLD target audiences are:

- Dam Owners –Board Members and Local Government Councilors'; Senior Executives (Federal, State, Territory, Local Government, Mining, Private).
- Dam Owners - Managers of Dams and Dam Safety
- Dam Operators

- Dam Professionals working for Dam Owners; Regulators; Consultants and Contractors. This includes Civil, Mechanical, Electrical, Environmental, Geotechnical and Mining Engineers, Engineering Geologists and Hydrologists.
- Civil, Mechanical, Electrical, Environmental, Geotechnical and Mining Engineers, Engineering Geologists and Hydrologists seeking post graduate training on dams.
- Persons who wish to become dam operators.
- Persons who manage and operate hydro-electric power stations which are associated with a dam (particularly where the power station owner is not the dam owner).
- Persons who manage retarding basins.
- Undergraduate and Graduate Students.

It is recognised that within the Owner and Management groups there are organisations with large portfolios of dams, often with dam professionals on the staff, through to others who may manage a single dam with little or no in-house knowledge of dams.

4 TARGET AUDIENCE TRAINING AND DEVELOPMENT NEEDS

4.1 Managers, Operators and Dam Professionals

Tables 1, 2 and 3 summarize in general terms the needs of each of the main groups of Target Audiences. Persons managing retarding basins and hydro-electric power stations would draw from these as required.

The working Group saw most of these as high priority needs based on their experience.

The courses for Operators are being developed as part of the NWP06 Qualifications Framework. The draft Course outline is included as Appendix C

4.2 Civil, Environmental, and Geological Engineers seeking post graduate training on dams.

The Working Group discussed the possibility of developing a formal Master of Engineering Science program at an Australian University. This would include courses in:

- Flood Hydrology including extreme events and construction floods
- Environmental impacts and management of dams
- Geotechnical investigations of dams
- Geotechnical engineering of embankment and concrete dams
- Design and construction of concrete dams including RCC
- Hydraulic design of spillways, and outlet works including use of CFD and physical models
- Failure Modes analysis, and quantitative risk assessment.

- Management of dam safety, including DSEP's, monitoring and surveillance.
- SEED
- Design of retaining walls, and appurtenant structures
- Foundation engineering (grouting, cut-offs, anchors)

The program would draw on existing M.Eng.Sc. Courses so far as practical but would include courses specifically designed for ANCOLD where no suitable courses were available. Several of these could be as detailed in Table 3 and could be run with M.Eng.Sc. Students and other Dam Professionals attending as has been done at UNSW. It is vitally important for the success of the program that a substantial number of places on courses are reserved for those dam professionals who are not full time students.

In practical terms the program would have to be based at one University, probably UNSW which has the largest M.Eng.Sc program in Australia. All courses would be delivered in short course format with attendance for 3 or 5 days, and assessment by assignment and examination.

It is likely several courses and parts of courses would have to be delivered by practising dam engineers and associated professions as the Universities are unlikely to have the skills required for all disciplines. This is already done in several courses in Geotechnical Engineering at UNSW. Some Courses could be run at another University and the credits transferred to UNSW for the degree.

If ANCOLD is interested in developing such a program it is suggested that discussions be held with UNSW School of Civil and Environmental Engineering to see if it is practical to do so.

There is a precedent for the School at UNSW developing such a program as they have recently done so with a major Australian Construction Company.

It would be anticipated that Dam professionals seeking a career in dam engineering would undertake the degree formally, or receive an ANCOLD certificate of attendance if they chose not to do any assessment. Professionals with some industry experience should be encouraged to enrol in courses to bring their experiences and real life examples to share with the course.

4.3 Undergraduate Civil and Environmental Engineering Students

The Working Group did not discuss this in any detail. The experience of Robin Fell is that the undergraduate curricula are overloaded and there is little or no room for specialist courses. This can be explored more at a later date.

5 MODES OF DELIVERY AND PRIORITIES FOR DELIVERY OF PROGRAM

5.1 Delivery Modes for Seminars and Courses

The Working Group saw most of the training listed in Tables 1 and 3 being delivered as courses or seminars with the presenters being selected from Australian and New Zealand organisations who are associated with ANCOLD or NZSOLD. There may be some involvement from Universities but the bulk of the presenters will be from industry.

There may be advantages in coupling selected courses to be programmed before or after ANCOLD meetings, but the Working Group expected most would be scheduled separately from the ANCOLD meeting.

5.2 Delivery Mode for Courses for Operators

The Courses detailed in Table 2 are being developed for TAFE Colleges. They would be delivered where there are suitable presenters. ANCOLD would have a role in encouraging its members to act as presenters.

5.3 Study Tours and Visits to Construction Sites

The Working Group believes that there are considerable benefits in arranging for visits to dam construction sites. These should be directed towards the Dam Professionals who have limited opportunities to see dams under construction or being upgraded.

Most benefit would be achieved if these are for say two days so there is sufficient time for the designers, contractors, and where appropriate review panel members to present details of the project. It should be made clear in publicity that these are learning sessions and more than just progress viewing opportunities. This should be done on an opportunist basis but requires a concerted effort on behalf of ANCOLD to see that access is obtained to such sites.

5.4 Priorities

It is expected that the Program of Seminars and Courses detailed in Tables 1 to 3 would be delivered over several years, say 3 to 5 years. Some may be delivered in several venues, but it should be recognized that this imposes a greater load on the presenters.

It is suggested that priorities and a program of courses be developed after the ANCOLD membership have a chance to comment on the proposed program.

5.5 Organisation of Seminars and Courses

It is understood that ANCOLD would use Conference Organisers to arrange the courses and seminars including the venues, and all financial matters. How the courses would be funded and to what extent ANCOLD subsidises the courses are a policy matter for ANCOLD to decide.

It should be recognized that presenters have to spend more time preparing their presentations than delivering them, and that this all affects their normal employment. While many potential presenters and their employer's will be willing to contribute some time free, ANCOLD should expect that some payment will be required.

The financial model will need to be considered in more detail at a later date.

6 OTHER MATTERS FOR CONSIDERATION

The Working Group discussed several other related matters:

(a) Collaboration with NZSOLD

The Working Group can see advantages in working together with NZSOLD in this endeavour. These include:

- The economies of scale by combining the two groups.
- The availability of expert presenters in New Zealand.
- Exposure of participants to a wider range of experiences.
- Increasing the pool and providing some consistency in training for future dam practitioners

Peter Amos will be advising the NZSOLD executive of the Working Group's meeting. He is currently Vice Chairman of NZSOLD.

(b) Presentation of new ANCOLD Guidelines

The working Group suggests that Workshops and Seminars to introduce new and revised ANCOLD Guidelines be included in the program.

(c) Role of the Working Group

The Working Group would all be interested in further developing this program and to having an on-going role in planning courses, course content, quality control, and selecting persons who may be suited to presenting.

We expect that ANCOLD (and NZSOLD if they join with ANCOLD) would need such a group to manage the program, reporting to the ANCOLD (and NZSOLD) executive.

Table 1. Summary of Dam Industry Training and Development Needs - Owner Management Groups

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
Board Members and Local Government Councilors’; Senior Executives	M1	Management of Dams for Boards and Executives. <ul style="list-style-type: none"> • Roles and responsibilities of Board Members and Local Government Councilors’; Senior Executives in dam safety management. • Hazards and risks imposed by dams; Low frequency – high consequence hazards; Risk based decision making; the role of ANCOLD Risk Management Guidelines; the role of the Regulator. • The importance of a dam safety management plan, monitoring and surveillance, hazard and risk mitigation principles, emergency action plans. 	Half Day Seminar (2 to 4 hours).
Managers of Dams and Dam Safety	M1	Management of Dams for Boards and Executives (as above)	Half Day Seminar (2 to 4 hours).
	M2	Dam Safety Emergency Plans (DSEP’s). <ul style="list-style-type: none"> • Development and application of DSEP’s. • Incident management • Organisational aspects of DSEP’s 	One Day Seminar
	M3	Fundamentals of Dam Engineering and Performance <ul style="list-style-type: none"> • Hydrology, floods • Embankment dams and their foundations • Concrete dams and their foundations • Spillways • Gates, Valves, Controls • Performance of dams (deformations, seepage etc.) 	Two Days Course

Table 1. Summary of Dam Industry Training and Development Needs - Owner Management Groups continued

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
Managers of Dams and Dam Safety (cont'd)	M4	Failure Modes and Effects Analysis (FMEA)-Civil <ul style="list-style-type: none"> • Concepts of FMEA • Examples of FMEA for embankments, concrete dams, spillways, appurtenant structures. • Relationship to monitoring and surveillance 	One or Two Days? Course
	M5	Failure Modes and Effects Analysis (FMEA)-Mechanical, Electrical and Control <ul style="list-style-type: none"> • Concepts of FMEA • Examples of FMEA for gates, valves, hoists, controls. • Relationship to monitoring and surveillance 	One or Two Days? Course
	M6	Introduction to Quantitative Risk Assessment (QRA) and Risk Management of Dams <ul style="list-style-type: none"> • ANCOLD Risk Management Guidelines • Tolerable Life Loss risks • Business Risks • Response to outcomes of QRA • Risk mitigation 	One Day Seminar
	M7	Monitoring and Surveillance of Dams <ul style="list-style-type: none"> • Design of a monitoring and surveillance program. • Data collection and recording • Assessment of data 	One or Two Days? Course
	M8	Asset Management of Dams <ul style="list-style-type: none"> • Mechanical. Electrical and Controls • Civil • Security 	One or Two Days? Course

Table 1. Summary of Dam Industry Training and Development Needs - Owner Management Groups continued

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
	M9	Environmental Management of Dams-an Overview <ul style="list-style-type: none"> • Catchment management • Downstream effects of releases • Fish Passage • Water quality management • Siltation Social Issues	One Day Course

Table 2. Summary of Dam Industry Training and Development Needs – Operators and persons wishing to become operators

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
Operators	O1	Monitor and Implement dam maintenance	TAFE NWP Training
	O2	Monitor and operate gated spillways	
	O3	Monitor and operate gates and valves, bulkheads	
	O4	Monitor and control dam operations	
	O5	Conduct and report on dam safety inspection and monitoring	
	O6	Monitoring and operation of tailings dams	
	O7	Fundamentals of Dam Engineering and Performance, and relation to monitoring and surveillance	Two days Course. Maybe M3 or modified to suit

Table 3 Owner, Regulator and Consultant Dam Professional Groups

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
All Groups	M4	Failure Modes and Effects Analysis (FMEA)-Civil <ul style="list-style-type: none"> • Concepts of FMEA • Examples of FMEA for embankments, concrete dams, spillways, appurtenant structures. • Relationship to monitoring and surveillance 	One or Two Days? Course
All Groups	M5	Failure Modes and Effects Analysis (FMEA)-Mechanical, Electrical and Control <ul style="list-style-type: none"> • Concepts of FMEA • Examples of FMEA for gates, valves, hoists, controls. • Relationship to monitoring and surveillance 	One or Two Days? Course
All Groups	M6	Introduction to Quantitative Risk Assessment (QRA) and Risk Management of Dams <ul style="list-style-type: none"> • ANCOLD Risk Management Guidelines • Tolerable Life Loss risks • Business Risks • Response to outcomes of QRA • Risk mitigation 	One Day Seminar
Owner, Regulator Groups	M7	Monitoring and Surveillance of Dams <ul style="list-style-type: none"> • Design of a monitoring and surveillance program. • Data collection and recording • Assessment of data 	One or Two Days? Course
Owner Group	M8	Asset Management of Dams <ul style="list-style-type: none"> • Mechanical. Electrical and Controls • Civil • Security 	One or Two Days? Course

Table 3 Owner, Regulator and Consultant Dam Professional Groups Cont'd

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
All Groups	P1	Safety Evaluation of Existing Dams (SEED)	One (or two?) Week Course??
	P2	Failure Modes Analysis and Design of Monitoring and Surveillance programs for Dams	Workshop followed by Two(?) day Course
All Groups	P3	Design and Operation of Electrical and Mechanical Control Systems for Dams	Workshop followed by Two(?) day Course
All Groups	P4	Life Cycle Management of Dams and Appurtenant Structures	Two Days? Course
All Groups	P5	Details of Quantitative Risk assessment and Management of Dams <ul style="list-style-type: none"> • Detailed Failure Modes Analysis • Risk analysis methods; e.g. Piping toolbox • Consequence analysis • Risk analysis details (partitioning, combination of risks, common cause effects, length effects, etc) 	Two to 5 days Course depending on content
Consulting	P6	Geotechnical models of dams and their foundations <ul style="list-style-type: none"> • Geological Environments and what to anticipate in dam foundations • Assessment of geotechnical information in the context of the geology of the dam site. • Plotting and interpretation of geotechnical data. 	Three Days Course
Consulting	P7	Assessment of the strength and compressibility of rock foundations for concrete dams Assessment of defect controlled failure mechanisms	Three days Course including field component

Table 3 Owner, Regulator and Consultant Dam Professional Groups Cont'd

TARGET AUDIENCE	DESIGNATION	TRAINING AND DEVELOPMENT NEEDS	DURATION AND DELIVERY MODE
All groups	P8	<p>Internal erosion and piping of dams</p> <ul style="list-style-type: none"> • The mechanics of internal erosion and piping, including concentrated leak, backward erosion and suffusion. • Zoning of dams for internal erosion control. • Filter design and assessment of filters which do not satisfy modern design criteria 	Two Days
All Groups	P9	<p>Failure Modes Analysis and Risk Management for Tailings Dams</p> <ul style="list-style-type: none"> • Differences between tailings dams and conventional dams. • Tailings deposition and the effects on properties. • Water management and operation • Upstream construction and the assessment of stability • Design for earthquakes, liquefaction. 	Two day Course
All Groups, also Management	P10	Failure Modes Assessment and Risk Management of Retarding Basins	One day Seminar
All Groups	P11	<p>Retaining Wall Design and Assessment</p> <ul style="list-style-type: none"> • Need for proper geotechnical model • Assessment of design loads • Design for earthquake including liquefaction 	One Day Seminar/Course
All Groups	P12	<p>Geotechnical Engineering of Dams.</p> <p>Zoning of embankment dams. Site investigations planning, and techniques, seepage control measures, and the design and specification and construction of filters. Stability analysis under normal loads for embankment and concrete gravity dams. Foundation preparation, cleanup and grouting. Detailing of embankment dams. Specification and quality control. Design of embankment dams for earthquake; selection of design earthquake; general design principles,</p>	Five Days Course

		defensive design. Analysis of dynamic stability, and deformations of embankment dams. Assessment of liquefaction potential and post liquefaction behaviour. Design of remedial measures.	
All Groups	P13	<p>Structural Engineering of Concrete Dams and Appurtenant Structures</p> <ul style="list-style-type: none"> • Material properties • RCC • Analysis techniques • Design Criteria • Dam/foundation interaction • Seismic analysis • Design of remedial works 	Three day course
All Groups	P14	<p>Foundation Engineering for Dams</p> <ul style="list-style-type: none"> • Seepage control grouting of dam foundations • Consolidation grouting • Sealing high pressure leaks • Cut-off walls and barriers • Anchors • Ground improvement techniques to prevent liquefaction 	Three to five day course
All Groups		<p>Earthquake Engineering of Dams</p> <ul style="list-style-type: none"> • Seismic hazard assessment • Reservoir hazards • General design principles for embankment and concrete dams for earthquake • Remedial works for dams • Appurtenant structures • Analysis of gates and lifting gear • Loads on low level outlet 	Three days

APPENDIX A. Brief for Development of Position Paper on Dam's Industry Training and Development Needs

Background

ANCOLD seeks to develop a position paper outlining the training and development needs of the Australian dams industry.

The position paper will provide a foundation on which ANCOLD can plan to support the provision of professional development opportunities for members.

Initially this will provide an input to the ANCOLD forward budget development. The position paper will be presented to the membership at the 2009 AGM and subject to members' endorsement, will underpin the development of a program of professional development opportunities for the ANCOLD membership.

Issues for Consideration

The paper needs to consider such things as:

- the full spectrum of ANCOLD membership including dam owners, regulators, consultants, contractors
- varying levels of experience of industry personnel including undergraduate, graduate, experienced professionals and non-technical/operations staff
- appropriate forms of development opportunities such as seminars, short courses, study tours, lectures (to undergraduate courses), etc
- range of technical issues and disciplines that could be addressed
- opportunities to collaborate with NZSOLD in developing and delivering a professional development program

Working Group

In preparing the position paper it is considered a working group with representation of the range of membership and technical expertise should be convened. A suggested membership for the Working Group is:

- Robin Fell – Academia / Geotechnical
- Norm Himsley – Regulator
- Phil Cummins – General Dams Engineering
- Stuart Richardson – Dam owner / Operations / Mechanical/Electrical Engineering
- Peter Hill - Consulting / Hydrology
- Murray Gillon – NZ perspective

Output

The desired output is a prioritized outline/matrix of professional development needs across the ANCOLD membership along with recommendations on how these needs may be met.

Timing

So that the position paper can be considered in preparation of the forward budget it is desired that the paper be available for the Executive's consideration by the end of July 2009.

APPENDIX B

AUSTRALIAN NATIONAL COMMITTEE ON LARGE DAMS

Working Group on Dams Industry Professional Development

Venue QANTAS Club Meeting Rooms - Melbourne Airport

Time 10.00 am Monday 20th July

Attendees

Robin Fell, Chair
Phil Cummins
Norm Himsley
Peter Hill
Peter Amos
Stuart Richardson

Workshop Agenda

ITEM	
1. Introduction (purpose of workshop)	Robin Fell
2. Identification of target audiences	All
3. Identify each audience's need(s)	All
4. Identify approaches to deliver on needs (topics, formats, etc.)	All
5. Set priorities for delivery of Program	All
6. Identify potential contributors to delivery of program	All
7. Role of Working Group in delivering the program, and membership of the Working Group	All
8. Agree follow-up actions and reporting to ANCOLD Executive	Robin Fell

APPENDIX C

NWP369A	Conduct and report dam safety instrumentation monitoring
Unit descriptor	<p>This unit of competency describes the outcomes required to plan, implement and report on the monitoring of basic instrumentation installed in dams to provide assurance of their ongoing safety.</p> <p>This unit of competency is one of three which replaces NWP325B Conduct and report on dam safety inspection and basic monitoring.</p>
Employability Skills	This unit of competency contains employability skills.
Pre-requisites	NWP201B Follow defined OHS procedures and regulatory requirements
Co requisites	<p>Co-requisite - one or both of:</p> <p>NWP370A Inspect and report on concrete dam safety NWP371A Inspect and report on embankment dam safety</p> <p>BSBOHS303A Contribute to OHS hazard identification and risk assessment</p>
Application of the unit	<p>This unit supports the attainment of skills and knowledge required for staff with a specific responsibility for monitoring the safety of a dam and timely reporting of identifiable faults or trends to allow early rectification.</p> <p>The unit of competency is part of the skills sets:</p> <ul style="list-style-type: none"> • Monitor and inspect concrete dams. • Monitor and inspect embankment dams.

ELEMENT	PERFORMANCE CRITERIA
Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.
1 Plan and prepare for dam safety	<p>1.1 Identify <i>organisational procedures and guidelines</i> for dam safety monitoring.</p> <p>1.2 Identify and apply operational procedures determining</p>

<p>monitoring.</p>	<p>the techniques, methods and equipment used for dam safety monitoring.</p> <p>1.3 Schedule work activities according to workplace requirements and data collection equipment and methods.</p>
<p>2 Conduct dam safety monitoring.</p>	<p>2.1 Implement dam monitoring procedures and practices including unusual events according to organisational and statutory requirements and procedures.</p> <p>2.2 Ensure equipment is functioning and fit for purpose.</p> <p>2.3 Take and record dam instrumentation readings to the required level of accuracy and frequency.</p> <p>2.4 Recognise and report any monitoring data that may indicate faults or changes outside expected range.</p>
<p>3 Report on dam safety monitoring.</p>	<p>3.1 Add newly recorded information on dam behaviour to historical monitoring information.</p> <p>3.2 Prepare and submit accurate, timely, clear and concise monitoring instrumentation data to meet organisational requirements.</p> <p>3.3 Report deviations outside approved limits including potential causes and make recommendations for follow up action.</p>

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge and their level, required for this unit.

Required Skills

- Follow instructions, standard operating procedures, policies and standards
- collect and process data
- read and interpret plans, drawings and charts
- produce dam instrumentation monitoring reports
- inspect and operate monitoring equipment and instruments
- communicate deviations and faults in equipment and data
- apply occupational safety protocols.

Required knowledge:

- Principles of dam design and construction
- causes of dam failures and incidents
- impact of unusual events on dam safety
- types of instrumentation and their application

DRAFT Certificate III in Water Operations – Dam Safety – V4

- installation of instruments and what can go wrong
- purpose of monitoring and instrumentation used
- instructions for the operation of monitoring equipment
- dam safety performance indicators
- OH&S procedures related to dam monitoring
- dam faults and changes indicated by monitoring and instrumentation
- organisational and statutory requirements related to monitoring and reporting dam safety.

RANGE STATEMENT	
<p>The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the Performance Criteria, is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.</p>	
<p><i>Organisational procedures and documentation</i> will include:</p>	<ul style="list-style-type: none"> • ANCOLD guidelines • dam monitoring templates and proformas • relevant regulator’s technical bulletins • occupational health and safety information • operation and maintenance information and manuals • instrumentation records, plans and manuals • dam safety performance indicators • roles, responsibilities and delegations for instrumentation monitoring and action • security and storage of data • dam safety inspection manuals. • past inspection reports design and construction reports, surveillance reports and risk assessments.
<p><i>Unusual events</i> will include</p>	<ul style="list-style-type: none"> • Seismic events • floods • extreme infows • rapid draw down • landslides and slips • dam incidents • sabotage/terrorist attack • fires • long term low storage levels.

RANGE STATEMENT	
<p><i>Dam safety monitoring techniques and details:</i></p>	<ul style="list-style-type: none"> • Monitoring details will include: <ul style="list-style-type: none"> • adequate timeframe and resources • visual observation • use of manual, electronic and/or computer equipment • operational preparedness checks • dam condition assessments • site security and access • dam safety emergency indicator reporting • checklists and previous monitoring reports • sites to be monitored may include: <ul style="list-style-type: none"> • earthen walls and/ or embankments • concrete walls and structures • hydraulic structures • monitoring equipment • spillways/ diversions systems • outlet works/ intake structures • pipes/ conduits • abutments and foundations • reservoir perimeter and downstream areas • weirs • tunnels and galleries • drainage systems. • monitoring data will include: <ul style="list-style-type: none"> • seepage and leakage • pore pressures • stresses and strains • water levels • movements (external and internal) • rainfall • temperature.
<p><i>Dam instrumentation</i> will include those used in the workplace from the range:</p>	<ul style="list-style-type: none"> • Seepage measurement devices • water level recorders • piezometers/stand pipes • extensometers • earth pressure cells • cross arms • hydrostatic settlement cells

RANGE STATEMENT	
	<ul style="list-style-type: none"> • pendulums • inclinometers • strain gauges • crack monitoring instrumentation • joint meters • external survey systems • rain gauges • thermometers.
<p>Organisational and statutory requirements will include:</p>	<ul style="list-style-type: none"> • Prescribed surveillance schedules • ANCOLD guidelines • Occupational Health and Safety regulations and procedures • incident management plans • data storage and security • state and local government requirements • Standard Operating Procedures • asset management plan.
<p>Faults and changes will include:</p>	<ul style="list-style-type: none"> • Stresses / strains • pore pressures • slumps, slips and slides • earth pressures • seepage and leakage • misalignment/ movement • weather conditions.

EVIDENCE GUIDE	
<p>The evidence guide provides ADVICE on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for the Training Package.</p>	
<p>Critical aspects for assessment and evidence required to demonstrate competency in this unit</p>	<p>The candidate should:</p> <ul style="list-style-type: none"> • demonstrate consistent performance for each element across a representative and routine range of applications in the workplace • meet the performance criteria by using the techniques, procedures, information and resources available in the workplace from those relevant in the range statement • demonstrate an understanding of the required knowledge and skills through evidence gathered in training, workplace applications and the use of scenarios and

EVIDENCE GUIDE	
	<p>workplace assignments.</p> <p>The candidate should demonstrate:</p> <ul style="list-style-type: none"> • preparation of monitoring activity • gathering • set up relevant instrumentation • interpreting and applying all relevant organisational and regulatory information and requirements in planning dam safety monitoring activities • identifying dam safety monitoring sites and scheduling activities according to the required frequency of reporting • conducting inspection and monitoring activities using standard workplace equipment and instruments • gathering and recording data • identifying faults, changes and failure indicators • reporting on dam safety monitoring outcomes, with recommendations for action.
<p>Context of and specific resources for assessment</p>	<p>Access to the workplace and resources including:</p> <ul style="list-style-type: none"> • documentation that should normally be available in dam operation worksites • codes, standards, and government regulations relevant to monitoring dam safety. <p>Candidates should have access to on and off the job learning and assessment support when evidence is inadequate and competency has not yet been achieved.</p> <p>Candidates' level of English language and literacy should be taken into account in designing assessment and adjustments should be recorded in assessment plans.</p> <p>Validity and sufficiency of evidence requires that:</p> <ul style="list-style-type: none"> • competency will need to be demonstrated over a period of time reflecting the scope of the role and the practical requirements of the workplace • a decision of competence should only be

EVIDENCE GUIDE	
	<p>made when the assessor has complete confidence in the person's competence over time and in various contexts</p> <ul style="list-style-type: none"> • all assessment that is part of a structured learning experience must include a combination of direct, indirect and supplementary evidence • where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to be authenticated and show that it represents competency demonstrated over a period of time • assessment can be through simulated project-based activity and must include evidence relating to each of the elements in this unit. <p>In all cases where practical assessment is used it will be combined with targeted questioning and examination to assess the underpinning knowledge. Questioning will be undertaken in a manner appropriate to the skill levels of the operator, any cultural issues that may affect responses to the questions, and reflecting the requirements of the competency and the work being performed.</p>
Method of assessment	<p>This unit of competency should be assessed in conjunction with NWP370A and NWP371A</p> <p>The following assessment methods are suggested:</p> <ul style="list-style-type: none"> • testing knowledge through questioning and explanations in essential requirements such as work site safety and in procedures and regulatory standards • observation of performance under supervision in the workplace or in a simulated workplace reflecting workplace conditions • using combined evidence from technical competencies which overlap with the knowledge and skills of this unit • checking compliance of routine workplace reports and documentation • performance reports from supervisors.

NWP370A	Inspect and report on concrete dam safety
Unit descriptor	This unit of competency describes the outcomes required to plan, implement and report on concrete and masonry dam safety inspection. Conduct routine visual inspection, capture and report dam condition and faults in dams constructed primarily of concrete or masonry. Dam safety operators should be aware of the damage potential of the dam and be able to recognise and report deficiencies, or adverse trends that could lead to failure .
Employability Skills	This unit of competency contains employability skills.
Pre-requisites	NWP201B Follow defined OHS procedures and regulatory requirements
Co-requisites	Co-requisite NWP369A Conduct and report dam safety instrumentation monitoring BSBOHS303A Contribute to OHS hazard identification and risk assessment
Application of the unit	This unit supports the attainment of skills and knowledge required for staff with a specific responsibility for the inspection of concrete dams and timely reporting of identifiable faults or trends to allow early rectification. This unit forms part of the skills set for: Monitor and inspect concrete dams

ELEMENT	PERFORMANCE CRITERIA
Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the required performance needed to demonstrate achievement of the element. Where <i>bold italicised</i> text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.
1 Plan and prepare concrete dam inspection	<p>1.1 Identify and apply the relevant <i>organisational procedures and proformas</i> relating to concrete dam safety inspection.</p> <p>1.2 Identify <i>features of concrete dam types and their applications</i> relevant to the dams to be inspected.</p> <p>1.3 Identify concrete <i>dam behaviour</i> under a range of <i>conditions</i>.</p>

ELEMENT	PERFORMANCE CRITERIA
	1.4 Assess information from checklists and previous inspection reports. 1.5 Schedule activities and equipment for concrete dam inspection according to workplace requirements.
2 Inspect and assess the condition of components of concrete dams	2.1 Implement concrete dam inspection procedures and practices including for unusual events according to organisational requirements ,. 2.2 Inspect and assess the condition and performance of identified areas and features of the concrete dam. 2.3 Recognise, record and assess any faults and changes in the condition of the concrete dam and its appurtenant structures .
3 Report the condition of the components of the concrete dams	3.1 Compare observations with previous inspection reports. 3.2 Collect and record evidence to establish the extent of changes in conditions. 3.3 Prepare and submit inspection reports to meet organisational requirements. 3.4 Report significant changes and deviations with recommendations for follow up action.

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge, and their level required for this unit.

Required Skills

- Follow instructions, standard operating procedures, policies and standards for concrete dam safety
- plan and organise work schedules and responses to contingencies
- communicate with engineering professionals, team members and the public
- identify concrete dam faults and failure indicators
- assess the importance and urgency of deficiencies
- collect and process observation information
- read and interpret plans, drawings and charts
- produce inspection reports
- identify safety hazards and implement safety protocols
- use digital photography and locational equipment.

Required knowledge:

- Concrete dam types, elements, and failure modes
- historic information and lessons from previous concrete dam incidents
- properties of stored water

REQUIRED SKILLS AND KNOWLEDGE

- concrete dam design and construction principles, including basic:
 - materials science
 - hydraulics
 - aging of concrete
 - concrete technology
 - treatment of foundations, grouting and drainage systems
 - post tensioning principles
 - principles of gravity action
 - principles of arch action
 - principles of buttress action
 - principles of roller compacted concrete
 - uplift pressures and drainage systems
- dam performance history
- principles of concrete dam inspection
- occupational health and safety and personal work site safety
- organisational and statutory requirements
- concrete dam faults and change indicators.

RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the Performance Criteria, is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

Unusual events will include

- Seismic events
- floods
- extreme infows
- rapid draw down
- landslides and slips
- dam incidents
- sabotage/terrorist attack
- fires
- long term low storage levels.

Organisational and regulatory information will include:

- ANCOLD guidelines
- past inspection reports, surveillance reports and risk assessments
- survey information
- relevant regulator's technical bulletins
- occupational health and safety information

DRAFT Certificate III in Water Operations – Dam Safety – V4

RANGE STATEMENT	
	<ul style="list-style-type: none"> • operation and maintenance manuals • dam performance history • dam safety performance indicators • dam safety inspection manuals and may include: <ul style="list-style-type: none"> • design and modification plans and reports • construction records and reports.
Assess will include:	<ul style="list-style-type: none"> • Analyse observations • make judgements of urgency and seriousness of problem • priorities for action
Identified areas and features will include:	<ul style="list-style-type: none"> • Dam structure • concrete walls and structures • hydraulic structures • spillways/ diversions systems • outlet works/ intake structures • pipes/ conduits • abutments and foundations • access to areas • reservoir perimeter and downstream areas • weirs and monitoring installations • tunnels, galleries and drainage systems. and may include: <ul style="list-style-type: none"> • mechanical and electrical components including valves, winches, hydraulic and electrical systems • civil infrastructure including ladders, pipe work, and security • post tensioning anchors.
Dam behaviour will include:	<ul style="list-style-type: none"> • Horizontal and vertical movement of concrete dams • leakage and seepage through drainage systems under a range of weather and storage content situations • structural movements expected during and post earthquakes and may include: <ul style="list-style-type: none"> • vibration and water flow patterns.
Inspection techniques and details will include:	<ul style="list-style-type: none"> • Visual observation and note taking • use of manual, electronic and/or computer equipment and digital camera.

DRAFT Certificate III in Water Operations – Dam Safety – V4

RANGE STATEMENT	
	<ul style="list-style-type: none"> • dam condition assessments • site security • site access • concrete dam safety emergency indicator reporting • landslides and environmental conditions • details of concrete dam sites to be inspected.
<p>Organisational and statutory requirements will include:</p>	<ul style="list-style-type: none"> • ANCOLD guidelines • environmental laws and policies • Occupational health and safety regulations and procedures • incident management plans • public safety and disaster plans • state and local government requirements • Standard Operating Procedures • asset management plan.
<p>Faults and changes will include:</p>	<ul style="list-style-type: none"> • Cracks (existing and new) • drain blockage • seepage / leakage • cavitation • foundation piping • misalignment / movement / instability • settlement • concrete deterioration • alkali aggregate reaction • concrete defects <ul style="list-style-type: none"> • efflorescence • honeycombing • segregation • erosion • chemical attack • joint damage/deterioration • maintenance concerns (eg vegetation in joints or cracks/missing or damaged sealants and water bars/leaking or inoperative valves and gates/damaged monitoring instrumentation).
<p>Evidence may include:</p>	<ul style="list-style-type: none"> • Flood, rainfall and relevant weather information • seismic and other incident details • inspection findings • location and extent of faults and changes • photographs

RANGE STATEMENT	
	<ul style="list-style-type: none"> • monitoring data.

EVIDENCE GUIDE	
<p>The evidence guide provides ADVICE on assessment and must be read in conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for the Training Package.</p>	
<p><i>Critical aspects for assessment and evidence required to demonstrate competency in this unit</i></p>	<p>The candidate should:</p> <ul style="list-style-type: none"> • demonstrate consistent performance for each element across a representative range of applications • meet the performance criteria by using the techniques, procedures, information and resources available in the workplace from those relevant in the range statement • demonstrate an understanding of the required knowledge and the application of skills through testing, observation, scenarios and work based assignments. <p>The candidate should demonstrate the ability to:</p> <ul style="list-style-type: none"> • conduct and report on concrete dam safety inspection including: • interpreting and applying relevant organisational and regulatory information and requirements to the planning of safety monitoring activities • identifying inspection features and scheduling activities according to the required frequency • conducting concrete dam inspection activities gathering and recording data • identifying faults, changes and failure indicators • reporting on inspection and monitoring outcomes, with recommendations for action.
<p><i>Context of and specific resources for assessment</i></p>	<p>Access to the workplace and resources including:</p> <ul style="list-style-type: none"> • documents that should normally be available in dam workplace • codes, standards, and government regulations applying to dam monitoring. <p>Where applicable, physical resources should include equipment modified for people with disabilities.</p> <p>Access must be provided to appropriate learning and/or assessment support when required.</p> <p>Assessment processes and techniques must be culturally appropriate, and appropriate to the language</p>

EVIDENCE GUIDE	
	<p>and literacy capacity of the candidate and the work being performed.</p> <p>Validity and sufficiency of evidence requires that:</p> <ul style="list-style-type: none"> • competency will need to be demonstrated over a period of time reflecting the scope of the role and the practical requirements of the workplace • a decision of competence should only be made when the assessor has complete confidence in the person's competence over time and in various contexts • all assessment that is part of a structured learning experience must include a combination of direct, indirect and supplementary evidence • where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to be authenticated and show that it represents competency demonstrated over a period of time • assessment can be through simulated project-based activity and must include evidence relating to each of the elements in this unit. <p>In all cases where practical assessment is used it will be combined with targeted questioning and or examination to assess the underpinning knowledge. Questioning will be undertaken in a manner appropriate to the skill levels of the operator, any cultural issues that may affect responses to the questions, and reflecting the requirements of the competency and the work being performed.</p>
Method of assessment	<p>The following assessment methods are suggested:</p> <ul style="list-style-type: none"> • testing knowledge through questioning and explanations in essential requirements such as work site safety and in procedures and regulatory standards • observation of performance under supervision in the workplace or in a simulated workplace reflecting workplace conditions • using combined evidence from technical competencies which overlap with the knowledge and skills of this unit • checking compliance of routine workplace reports and documentation • performance and validation reports from supervisors.

NWP371A	Inspect and report on embankment dams safety
Unit descriptor	This unit of competency describes the outcomes required to plan, implement and report on embankment dam safety inspection. Conduct routine visual inspection, capture and report dam condition and faults in dams constructed primarily from earth and rock materials. Dam safety operators should be aware of the damage potential of the dam and be able to recognise and report deficiencies, or adverse trends that could lead to failure .
Employability Skills	This unit contains employability skills.
Pre-requisites	NWP201B Follow defined OHS procedures and regulatory requirements
Co-requisites	Co-requisite NWP369A Conduct and report dam safety instrumentation monitoring BSBOHS303A Contribute to OHS hazard identification and risk assessment
Application of the unit	This unit supports the attainment of skills and knowledge required for staff with a specific responsibility for the inspection of embankment dams and timely reporting of identifiable faults or trends to allow early rectification. This unit forms part of the skills set for: Monitor and inspect embankment dams

ELEMENT	PERFORMANCE CRITERIA
Elements describe the essential outcomes of a unit of competency.	Performance criteria describe the required performance needed to demonstrate achievement of the element. Where bold italicised text is used, further information is detailed in the required skills and knowledge and/or the range statement. Assessment of performance is to be consistent with the evidence guide.
1 Plan and prepare embankment dam inspection	<p>1.1 Identify and apply <i>organisational procedures and proformas</i> relating to embankment dam safety inspection.</p> <p>1.2 Identify <i>features of embankment dam types</i> and their applications to the dams to be inspected.</p> <p>1.3 Identify <i>embankment dam behaviour</i> under a range of</p>

ELEMENT	PERFORMANCE CRITERIA
	<p>conditions.</p> <p>1.4 Gather and validate checklists and previous inspection reports.</p> <p>1.5 Schedule activities for embankment dam inspection according to workplace requirements.</p>
<p>2 Inspect and assess the condition of components of embankment dams</p>	<p>2.1 Implement embankment dam inspection procedures and practices according to organisational requirements, including for unusual events.</p> <p>2.2 Inspect and assess the condition and performance of identified areas and features of embankment dams.</p> <p>2.3 Recognise, record and assess any faults and changes in the condition of the embankment dam and its appurtenant structures.</p>
<p>3 Report the condition of the components of embankment dams</p>	<p>3.1 Identify the purpose and audience of dam safety reports.</p> <p>3.2 Collect and record measurements and evidence to establish the extent of changes in conditions</p> <p>3.3 Prepare and submit reports to meet organisational requirements.</p>

REQUIRED SKILLS AND KNOWLEDGE

This describes the essential skills and knowledge, and the levels required for this unit.

Required Skills

- Follow instructions, standard operating procedures, policies and standards for embankment dam safety
- plan and organise work schedules and responses to contingencies
- communicate with engineering professionals, team members and the public
- identify embankment dam faults and failure indicators
- assess the importance and urgency of deficiencies
- collect and process embankment dam inspection observations
- read and interpret plans, drawings and charts
- produce embankment dam inspection reports
- apply safety hazards protocols
- use digital photography and locational equipment.

Required knowledge:

- Embankment dam types (including concrete faced rock fill dams), elements, zones, risks and failure modes
- historic information and lessons from previous embankment dam incidents

REQUIRED SKILLS AND KNOWLEDGE

- potential earthquake effects and damage
- properties of stored water
- embankment dam design and construction principles, including basic understanding of:
 - materials science (in particular soil and rock properties)
 - hydraulics and erosion by water
 - principles of filters, piping and embankment stability
 - treatment of foundations, grouting and drainage system
 - pore pressures
 - causes of cracks and settlement
- dam performance history
- principles of embankment dam inspection
- occupational health and safety and personal work site safety
- organisational and statutory requirements.

RANGE STATEMENT

The range statement relates to the unit of competency as a whole. It allows for different work environments and situations that may affect performance. Bold italicised wording, if used in the Performance Criteria, is detailed below. Add any essential operating conditions that may be present with training and assessment depending on the work situation, needs of the candidate, accessibility of the item, and local industry and regional contexts.

Organisational information requirements and proformas will include:

- ANCOLD guidelines
 - past embankment dam inspection reports, surveillance reports and risk assessments
 - survey information
 - relevant regulator's technical bulletins
 - occupational health and safety information
 - operation and maintenance information
 - dam performance history
 - dam safety performance indicators
 - dam safety inspection manuals.
- and may include:
- design and modification plans and reports
 - construction records and reports.

Features of embankment dam types and their applications will include:

- Soil mechanics and its application in dam embankments design
- foundations, grout curtains and filter systems
- spillway and water regulation options for a range of embankment dams

RANGE STATEMENT	
	<ul style="list-style-type: none"> • dam structure • embankment walls and structures • hydraulic structures • spillways/ diversions systems • outlet works/ intake structures • pipes/ conduits • abutments and foundations • access to areas • reservoir perimeter and downstream areas • weirs and monitoring installations • tunnels, galleries and drainage systems. <p>and may include:</p> <ul style="list-style-type: none"> • mechanical and electrical components including valves, winches, hydraulic and electrical systems • civil infrastructure including ladders, pipe work, and security • post tensioning anchors.
<i>Embankment dam behaviours will include:</i>	<ul style="list-style-type: none"> • Design of the embankment downstream, upstream and settlement movement of the embankment • leakage and seepage through drainage systems under a range of weather and storage content situations • structural vibration and water flow patterns of regulated and flood waters • structural movements expected during and post earthquakes.
<i>Inspection techniques and details will include:</i>	<ul style="list-style-type: none"> • Visual observation and note taking • use of manual, electronic and/or computer equipment and digital camera. • dam condition assessments • site security • site access • embankment dam safety fault indicator reporting • landslides and environmental conditions • details of sites to be inspected and monitored, including: <ul style="list-style-type: none"> • embankment crest, slopes and groins • downstream toe area

RANGE STATEMENT	
	<ul style="list-style-type: none"> • walls retaining earth/rock fill • spillways/ diversions systems • outlet works/ intake structures • pipes/ conduits • abutments and foundations • reservoir perimeter and downstream areas • weirs and monitoring installations • galleries
<p>Organisational and statutory requirements will include:</p>	<ul style="list-style-type: none"> • ANCOLD guidelines • environmental laws and policies • occupational health and safety regulations and procedures • incident management plans • public safety and disaster plans • state and local government requirements • Standard Operating Procedures • asset management plan.
<p>Faults and failures modes will include:</p>	<ul style="list-style-type: none"> • Cracks • slips • seepage • embankment and foundation piping • sinkholes • erosion and rutting • settlement and movement • deterioration • animal and human activity (eg burrowing / vandalism, maintenance concerns (eg dense overgrowth/blocked drainage/leaking, or inoperative valves and gates/damaged monitoring instrumentation)
<p>Measurements and evidence will include:</p>	<ul style="list-style-type: none"> • Flood, rainfall and relevant weather information • seismic and other incident details • inspection findings • location and extent of faults and changes • photographs • monitoring data.

EVIDENCE GUIDE
The evidence guide provides ADVICE on assessment and must be read in

EVIDENCE GUIDE

conjunction with the Performance Criteria, Required Skills and Knowledge, the Range Statement and the Assessment Guidelines for the Training Package.

Critical aspects for assessment and evidence required to demonstrate competency in this unit

The candidate should:

- demonstrate consistent performance for each element across a representative range of applications
- meet the Performance Criteria associated with each element by employing the techniques, procedures, information and resources available in the workplace from those listed in the Range Statement
- demonstrate an understanding of the requisite knowledge and the application of skills as described under Knowledge and Skills and as supplied by this unit.

The candidate should demonstrate the ability to:

- conduct and report on embankment dam safety inspection including:
 - interpreting and applying relevant organisational and regulatory information and requirements to the planning of inspection activities
 - identifying inspection features and scheduling activities according to the required frequency
 - conducting embankment dam inspection activities
 - gathering and recording data
 - identifying faults, changes and failure indicators
 - reporting on inspection and monitoring outcomes, with recommendations for action.

Context of and specific resources for assessment

Access to the workplace and resources including:

- documentation that should normally be available in a water industry organisation
- relevant codes, standards, and government regulations.

Where applicable, physical resources should include equipment modified for people with disabilities.

EVIDENCE GUIDE	
	<p>Access must be provided to appropriate learning and/or assessment support when required.</p> <p>Assessment processes and techniques must be culturally appropriate, and appropriate to the language and literacy capacity of the candidate and the work being performed.</p> <p>Validity and sufficiency of evidence requires that:</p> <ul style="list-style-type: none"> • competency will need to be demonstrated over a period of time reflecting the scope of the role and the practical requirements of the workplace • where the assessment is part of a structured learning experience the evidence collected must relate to a number of performances assessed at different points in time and separated by further learning and practice • a decision of competence should only be made when the assessor has complete confidence in the person's competence over time and in various contexts • all assessment that is part of a structured learning experience must include a combination of direct, indirect and supplementary evidence • where assessment is for the purpose of recognition (RCC/RPL), the evidence provided will need to be authenticated and show that it represents competency demonstrated over a period of time • assessment can be through simulated project-based activity and must include evidence relating to each of the elements in this unit. <p>In all cases where practical assessment is used it will be combined with targeted questioning or examination to assess the underpinning knowledge. Questioning will be undertaken in a manner appropriate to the skill levels of the operator, any cultural issues that may affect responses to the questions, and reflecting the requirements of the competency and the work being performed.</p>
Method of assessment	<p>The following assessment methods are suggested:</p> <ul style="list-style-type: none"> • assessment in the workplace or in a

EVIDENCE GUIDE

	<p>simulated workplace and under the normal range of workplace conditions</p> <ul style="list-style-type: none">• assessment conducted in conjunction with aspects of technical competencies that are consistent with the work environment• techniques for gathering evidence of competency may include:<ul style="list-style-type: none">• observation of performance• written and/or oral questioning to assess knowledge and understanding• completion of workplace documents and reports produced as part of routine work activities• third party reports from experienced practitioners• performance feedback from supervisors.
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