

ALASKA POWER AUTHORITY  
SUSITNA HYDROELECTRIC PROJECT

REPORT ON ACRES INTERNAL  
REVIEW BOARD MEETING NO. 3,  
NIAGARA FALLS, CANADA

FEBRUARY 10, 1981

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1. General Remarks by D. MacDonald/J. Lawrence
2. Project Development Selection: J. Hayden
3. Seismology: V. Singh
4. Geotechnical Field Program: V. Singh
5. General Arrangements: R. Ibbotson

## AGENDA

- 1 - 0900 - General Remarks
- 2 - 915 - Project Development Selection - Brief Introduction
- 3 - 1000 - Seismology - Recommended Design Parameters
  - (a) Acres' Specialist Consultants Panel Meeting - October 20-24, 1980
  - (b) Meeting with M. Copen - December 8 and 11, 1980
  - (c) Woodward-Clyde Report - January 1981
  - (d) APA Consulting Board Meeting - January 22-24, 1981
  - (e) Meeting with L. Sykes - January 29, 1981
- 4 - 1130 - Geotechnical Field Program - 1981
  - 1230 - LUNCH
- 5 - 1300 - General Arrangements
  - (a) Watana
  - (b) Devil Canyon
- 6 - 1400 - Main Dams
  - (a) Watana
  - (b) Devil Canyon
- 7 - 1530 - Construction Schedules
  - (a) Winter Work
  - (b) Rates of Placing, Excavation, Concreting, etc.
- 8 - 1600 - Future Review Subjects
  - 1630 - ADJOURNMENT

LIST OF ATTENDEES:

Internal Consultants Panel

Dr. D. MacDonald (Chairman)

A. Tawil

Dr. A. Burgess

I. McCaig

J. MacPherson

G. Thompson

Acres Project Team

J. D. Lawrence

Dr. J. W. Hayden

V. Singh

R. Henschel

R. Ibbotson

D. Meilhede

H. Eichenbaum

L. Duncan

1. General Remarks by D. MacDonald/J. Lawrence

- Brief review of AAI scope for Phase I - FERC license application
- Possible Phase II involvement, "fast track" approach if APA decides to start construction in 1985 - on line 1993. Project designed to meet wide range of power demands
- Project has very high profile both publicly and within the engineering community. Environmentally sensitive, seismically active area. Variety of boards and consultant review panels to insure technical quality.
- Acres subcontractors - status and scopes described.
- APA - Consultants Review Board, Acres External Board
  - \*Need to set up schedule of meetings for Acres External Board from now until March 1982.
- Points to be covered by Internal Review Board - those most pressing to Project Group at time of meeting. Keep panel membership flexible to meet Project needs, and to cover all aspects and disciplines as work develops, can vary as subject before board changes.

2. Project Development Selection: J. Hayden

- Brief Introduction - Project location and description of sites-- Devil Canyon is break point for salmon runs; dams located upstream to eliminate problems.
- Review: Task 6 Objectives, previous studies: identified 12 potential sites; Acres started with these, re-evaluated all separately and in conjunction with environmental screening; many eliminated on environmental aspects, others by economics; arrived at four "best" sites: Devil Canyon, Watana, High Devil Canyon and Vee; Devil Canyon/Watana and High Devil Canyon/Vee form best combinations; further evaluation of economics, power generation capacity, layouts of those two schemes - (briefly reviewed preliminary layouts of engineering of 4 sites)

Watana Site first to be built - therefore spent more time on preliminary design; Watana - 840' dam - developed new cross-section 2.5:1 U/s, 2:1 downstream slopes; cofferdam outside main damshell; looked at staged construction, economically not feasible; concrete arch structure - cost too high, no further evaluation

Also considered tunnel schemes - only one scheme cost effective, 150' rereg. dam and 15 mile tunnel to Portage Creek (lose about 20% energy, higher cost than Devil Canyon scheme); worked up preliminary layouts of dam and tunnel.

Took all schemes and performed economic (cost vs power generation analysis) Watana/Devil Canyon has best ratio; tunnel scheme is most costly.

Next looked at load growth and system comparison analysis (hydro, coal, gas turbine) and how they are fit together - preliminary economic evaluation of all schemes and alternative systems - Watana/Devil Canyon appear to be most cost effective (full height Watana and fast track)

3. Seismology: V. Singh

- Project extremely sensitive to seismic considerations. WCC performing studies for Acres.
- Review of seismic setting of site. Denali/Totschunda Fault System, Castle Mountain Fault and Benioff zone are controlling features.
- Brief review of WCC activities during 1980. Includes installation and operation of microseismic monitoring network, review of all the known faults and lineaments, field reconnaissance with subsequent identification of significant features for future study in 1981. (Total of 13 features - 9 at Devil Canyon, 4 at Watana)
- Reviewed data obtained from microseismic network. Several clusters of epicenters. WCC analysis shown no relationship of epicenters to known features. Planning installation of permanent network.
- Looked at response spectrum plots at Watana and Devil Canyon over known sources. Both sites are on high part of curves (i.e. high accelerations).
- Brief review of WCC proposed program for 1981. (Included seismology, geology and earthquake engineering activities).  
Important points discussed by panel:
  - a) possible connection of Broxon Gulch and Talkeetna thrust faults. If connected then there is direct tie to Denali Fault which is known to be active. Raises concern about activity of Talkeetna fault and also affects magnitude of earthquakes which occur.
  - b) For 1981 program - (Watana)
    - have to prove age of displacements along Talkeetna fault
    - prove/disprove Susitna feature
    - investigate KD3-7 (down river channel)
    - 'Fingerbuster' feature should also be included in studies
  - c) Panel considered three features which could have major effect on sites. Denali Fault (8.5M), Castlemountain Fault (7.5M), and Benioff zone (8.5M). Prime concern is Benioff zone (.4g). Feeling time magnitudes over conservative and could be refined downward. Accept known active features and look at those features which are not well defined as to activity and which are close to sites. For preliminary design only consider the three known features.
  - d) Reservoir induced seismicity is likely to occur but will have lower magnitude than design earthquake.
  - e) Need to address the question of a floating earthquake more fully and assign a magnitude to it. Dr. Lynn Sykes has suggested a method to do this. Involves a review and evaluation of historical earthquakes within Talkeetna terrain and a probabilistic approach to occurrence at the site.
  - f) Need to refine magnitude of earthquake associated with Benioff zone. Data from microseismic network shows decoupling zone to be located about 30 to 40 km. southeast of sites. Therefore, any major earthquake should be located even further southeast (<40 km) where plates are

still coupled. Expect smaller earthquakes associated with subducting plate directly under site. Evaluate attenuation to sites.

- g) Response spectra curves and attenuation models for both sites need to be defined.
- h) Dam design considerations:
  - For Watana, can design for known features, and also for cases where Talkeetna or Susitna features prove active. However if KD3-7 is active, then may have serious problem, because of surface rupture potential.
  - For concrete arch at Devil Canyon the magnitude of the earthquake and accelerations don't seem to have much effect on seismicity. Need to do analysis and generate stress levels in dam.

#### 4. Geotechnical Field Program: V. Singh

- Brief review of 1980 program activities and findings at Watana site.
- Outlined proposed 1981 program at Watana and reviewed recommendations of APA's consultants panel for additional work.
- Review of 1980 program activities and findings at Devil Canyon site.
- Outlined proposed 1981 program at Devil Canyon.
- Important points discussed by panel
  - a) Feeling that proposed 1981 program at Watana is very minimal program and doesn't address APA panel concerns. (Two holes in powerhouse area, two holes in relict channel and possibly an adit.)
  - b) Discussion on relict channel area
    - Preliminary cross sections and flow nets show a gradient of about 1:10 on 1:12 which is very high if you don't know infilling materials. Need to refine model further.
    - Remedial work is not required to prevent leakage unless piping occurs. May use blankets downstream or upstream.
    - Concern about excavating area D as it may aggravate the situation due to low saddle in that area.
    - Not necessary to investigate channel at this stage. If a problem arises, then it can be addressed. Allow adequate contingency for this situation
  - c) General conclusion that two additional holes in the relict channel area at this time will not provide much usable information. Recommend that additional seismic lines be used to better define the geometry of the channel and further analyses (flow nets) of performances to get handle on potential problems of leakage and piping. In future (after 1982) a more comprehensive program will have to be developed to fully investigate relict channel.
  - d) Discussion on additional holes in powerhouse area
    - Additional information is desirable. Don't feel that adit is required at this stage, although adits have been used on other projects during feasibility studies.
    - APA panel has recommended work, up to Acres to cost it out and decide necessity of the work.
  - e) General conclusion that at least one additional hole in the powerhouse would be useful. Second hole depending on what results of first hole are.

- f) Discussion on proposed 1981 program at Devil Canyon.
  - Feel that three proposed holes are bare minimum for FERC license application.
  - If Devil Canyon site is proven not to be feasible and a one dam scheme is then selected, Watana is not the best economic choice. High Devil Canyon is most cost effective single scheme. Therefore, feasibility of Devil Canyon should be verified at the same time as Watana.
  - Not likely that APA would only go for licensing of one site (Watana) and not the other (Devil Canyon) at this time.
- g) Concluded that nothing be taken out of program at Devil Canyon and that it be left in for licensing.

5. General Arrangements: R. Ibbotson

- Reviewed various layouts for development of the Watana site. These all included an earth-rockfill dam and underground powerhouse but the centerline location; powerhouse location; time, number and location of spillways; embankment slopes, etc. were varied.
- Comments of panel on Watana schemes
  - a) Spillway design
    - should not use unlined spillway, even for 1:10,000 year use, due to potential scour problem and associated repair costs.
    - must consider nitrogen saturation problem - use staircase or surface discharge
  - b) Fingerbuster Shear Zone
    - Controls dam centerline location to some extent (don't want to construct dam across it) Need to do enough drilling to define it.
    - What's wrong with building across shear zone if we don't expect any movement? Should only require excavation and treatment - Problem of seepage through shear zone
  - c) Powerhouse Location
    - like powerhouse on right abutment between fins and fingerbuster, on left abutment it is getting close to fingerbuster shear.
    - some concern with right abutment location from possible shears, low velocity zone (slide block?) and no borings.
  - d) Possibility of needing low level outlet for dewatering in emergency
    - possibility of using diversion tunnels, but flow would be about 90,000 cfs to allow drawdown in 4-5 months. Would sacrifice tunnels
    - will have to check on laws to see if any requirement
    - preference for using separately designed structure to handle this
    - Corps of Engineers looked at using diversion tunnels with blastable plugs for emergency drawdown.
    - need multi-level intake to control water temperature downstream for salmon spawning
    - Review several possible layouts for arch dam at Devil Canyon. Preferred scheme has service spillway on right abutment with emergency spillway on left abutment at end of saddle dam.
    - Preliminary design analyses have satisfied most conditions except for extreme drawdown. Results in tension cracks above water level due to thermal stresses. Copen says it has to be allowed for.



- No seismic input to analysis yet. Will be next step. Feel that most problems can be eliminated by prestressing.
- Comments by panel on Devil Canyon schemes.
  - a) Look at earthfill dam
    - have to use earthfill if potential for surface rupture
    - generally no disagreement with constructing arch at this site. Cost is about the same for both schemes.
    - Some reservations about high earthfill structure in narrow gorge in regards to cracking and settlement.
    - Have to identify material sources. Argillite may not make good rockfill, might have to consider river alluvium.
  - b) Some concern about case where extreme drawdown and tension cracking due to thermal stresses are coincident with earthquake. Not sure what will happen. Copen stated that probability of this case is extremely low and he is therefore not too concerned. Needs further review.
  - c) Discussion on construction schedule of Arch vs Earthfill
    - Fill dam takes longer, but powerhouse is controlling feature
    - Some concern about rates of placement of fill at Watana as to overall schedule. General opinion that experience from other dams would indicate that quarrying operations can be designed to meet quantities and required schedule.