Introduction:

GIA Annex 7 is concerned with advancement of geothermal drilling technology and, as part of this effort, Annex 7 participants plan to assemble a Handbook of geothermal drilling "Best Practices". This outline for the Handbook is posted on the GIA web site so that we can receive comments about its content from a variety of workers in the international geothermal industry. We are especially eager to learn whether there are topics that should be eliminated or covered in more detail. We have chosen to limit the scope of this initial effort, so that we can produce a draft version of a Handbook in a reasonable time, but this means that we have deliberately omitted some topics that are clearly crucial to any geothermal project. Specifically, the draft version of the Handbook will not address well maintenance, abandonment, or logging, and will only cover well testing to the extent that it affects the well design. With these restrictions, then, a summary of the Handbook content is below.

GEOTHERMAL DRILLING "Best Practices" HANDBOOK

Preface:

- Define the audience – drilling engineers, students, and general use
- Focused on the differences between geothermal and other drilling

Well design:

- Purpose of the well – production, injection, exploration, or workover?
- Reservoir conditions – previous temperature and pressure logs, thermal gradient holes, offset wells, other geophysical information?
- Logistical requirements – schedule, budget, lease or regulatory stipulations?
- Technical requirements – required production rate, casing diameter at production zone, expected depth, available tools or technology, are tools required to operate at high temperature?
- What are the likely problems - lost circulation, stuck pipe, twist-off, corrosion/erosion, tool failure from high temperature?
- Well trajectory – vertical, directional, or multi-leg? Where is the kick-off point, and how accurately must well be controlled?
- Casing design – number of strings, depths, diameters, strength, connections, and materials?
- Completion – open hole or slotted liner? Slotted liner design.
- Wellhead design – pressure requirements, expansion spool, welding, testing.

Drilling system selection:

- Conventional rotary, top-drive, or coring?
- Maximum hook load?
- Rig footprint? Number of loads to mobilize?
- Pump capacity?
- Fluid cleaning requirements?
- Drill string and BHA design?

- Drill bit selection
- Downhole motors or hammers?
- Availability of fishing tools?
- Define the information that will be on the request for bids?

Drilling fluids:

- Can water be used as drilling fluid? Advantages and disadvantages.
- If not water, then do we need more than simple bentonite mud?
- Are mud coolers needed?
- Polymers for viscosity, lubricity, yield – temperature limits?
- Need lost circulation material (LCM)?
- Aerated drilling fluids - pore-pressure gradient known?
- Can the hole be drilled with air or mist?

Well Control:

- Principal causes of blow-outs, and ways to avoid them/
- Estimate well temperature profile during drilling – maximum-reading thermometers, on-board logging tools, inflow/outflow temperature measurements.
- Accurate measurement of inflow and outflow is valuable.
- Establish a standard well-killing procedure.
- Blowout preventers (BOPs) – pressure and temperature requirements, choke and kill lines, kill water?

Lost circulation:

- Causes, treatments, costs.
- Locating loss zones by logging.
- Develop a lost-circulation strategy before drilling.

Cementing casing or loss zones:

- Regulatory requirements
- Selection of cement types and additives
- Placement problems and techniques

Instrumentation (drilling and mud-logging):

- Minimum instrumentation, and optional additions, on the rig?
- Use logging tools to solve drilling problems.
- Preparation for injection or discharge tests.