AUTOMATED GENERATION OF SPECTRUM
COMPATIBLE ARTIFICIAL TIME HISTORIES

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SUMMARY

Criteria for the seismic design of nuclear power plants are usually defined in the form
of response spectra. It is therefore generally necessary to generate artificial time histories
of ground motions to "match" these spectra. These time histories may then be used for
the generation of floor response spectra for the design of equipment and piping systems,
and for the nonlinear analyses of structures and equipment in case such analyses are war-
ranted. It is possible to generate a number of time histories to match a given spectrum.
However, to generate a time history with the necessary frequency and phase-angle con-
tents and other basic characteristics and at the same time achieve a desired match, it is
important to use a judicious combination of frequency-domain and time-domain proce-
dures, and to exert complete control over all the iterative steps. This paper presents such
a procedure.

State-of-the-art techniques are first reviewed for the generation of spectrum compatible
artificial time histories of ground motion. A recently developed completely automated itera-
tive procedure employing a combination of frequency-domain and time-domain tech-
niques in any desired sequence for the development of spectrum-compatible artificial time
histories is then presented. The procedure employs the following four basic steps: (1) gen-
eration of an initial (starting) time history using either sinusoidal superposition with an
envelope function or specification of a real time history of a recorded ground motion,
(2) manipulation of both the amplitude and the phase of the Fourier transform represen-
tation of this time history in accordance with criteria formulated from the comparison of
a computed response spectrum and the target response spectrum. Successive time histories
are then generated having response spectra converging to the target design spectrum,
(3) manipulation of the amplitude and phase of the Fourier transform representation only
locally in areas where the peaks of the computed spectra have larger magnitudes of de-
viations than desirable to obtain a closer match between the computed spectra and the
target spectrum, and (4) manipulation of local areas of the latest time history at times
where maximum response occurs.

A description of computer program EDAC/SEQGEN, which completely automates the
above steps, is then presented. The program employs efficient numerical algorithms, thus
enabling it to perform a number of iterations using much less computer time than in pre-
vious studies. Complete automation of all the above steps and inclusion of versatile plot-
ting options in the program considerably reduces engineer-computer interaction.

Results are presented for the development of two artificial time histories with corre-
sponding spectra matching the target USNRC Regulatory Guide 1.60 response spectra
within about 5 to 7 percent. The importance of inclusion of additional higher frequency
components and redistribution of phase angles in obtaining better control over the proce-
dure and excellent matches between the computed and the target spectra are also dis-
cussed. Recommendations for future studies are then presented.